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A PHONOLOGICAL AND TONAL ANALYSIS OF SAMUE USING OPTIMALITY THEORY

Virpi Ouattara

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ABSTRACT

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The topic of the present doctoral dissertation is the analysis of the phonological and tonal structures of a previously largely undescribed language, namely Samue. It is a Gur language belonging to the Niger-Congo language phulym, which is spoken in Burkina Faso. The data were collected during the fieldwork period in a Sama village; the data include 1800 lexical items, thousands of elicited sentences and 30 oral texts. The data were first transcribed phonetically and then the phonological and tonal analyses were conducted.

The results show that the phonological system of Samue with the phoneme inventory and phonological processes has the same characteristics as other related Gur languages, although some particularities were found, such as the voicing and lenition of stop consonants in medial positions. Tonal analysis revealed three level tones, which have both lexical and grammatical functions. A particularity of the tonal system is the regressive Mid tone spreading in the verb phrase.

The theoretical framework used in the study is Optimality theory. Optimality theory is rarely used in the analysis of an entire language system, and thus an objective was to see whether the theory was applicable to this type of work. Within the tonal analysis especially, some language specific constraints had to be created, although the basic Optimality Theory principle is the universal nature of the constraints. These constraints define the well-formedness of the language structures and they are differently ranked in different languages.

This study gives new insights about typological phenomena in Gur languages. It is also a fundamental starting point for the Samue language in relation to the establishment of an orthography. From the theoretical point of view, the study proves that Optimality theory is largely applicable in the analysis of an entire sound system.

Key words: phonology, tone, Niger-Congo languages, Gur languages, Optimality Theory

TIIVISTELMÄ

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Tämän tutkielman aiheena on vähemmistökieli samuen fonologinen ja tonologinen analyysi. Samue on laajalti aiemmin dokumentoimaton nigeriläis-kongolaisiin kieliin kuuluva Gur-kieli, jota puhutaan Burkina Fasossa. Aineisto työhön on kerätty samueta puhuvassa kylässä kenttäjakson aikana; se sisältää 1800 leksikaalista sanaa, tuhansia lauseita sekä 30 vapaasti puhuttua tekstiä. Aineisto transkriboitiin ensin foneettisesti, minkä jälkeen aineistosta tehtiin fonologinen ja tonologinen analyysi.

Tutkimus osoitti, että samuen äännejärjestelmä vastaa pääosin muiden Gur-kielten äännejärjestelmiä sekä käytössä olevien foneemien että fonologisten prosessien osalta. Tosin kielikohtaisia ilmiöitä myös esiintyy, kuten klusiilien heikentyminen puolivokaaleiksi sanan keskellä. Toonien osalta tutkimuksessa kävi ilmi, että kielessä esiintyvillä kolmella säveltasolla on sekä leksikaalisia että kieliopillisia funktioita kuten muissakin sukukielissä. Erityispiirteenä samuen toonijärjestelmässä on keskisen toonin leviäminen regressiivisesti verbilausekkeissa.

Teoreettisena viitekehyksenä tutkimuksessa sovellettiin Optimaalisuusteoriaa, jota on hyvin harvoin käytetty yhden kielen koko fonologisen järjestelmän analysointiin. Yhtenä tutkimuksen tavoitteena olikin selvittää, kuinka hyvin teoria soveltuu koko äännejärjestelmän tutkimukseen. Erityisesti toonien kohdalla tutkimuksessa jouduttiin luomaan kielikohtaisia rajoituksia, vaikka yksi keskeinen Optimaalisuusteorian perusperiaate ovat universaalit rajoitukset, jotka määrittelevät kielen rakenteiden oikeellisuuden ja joita kielissä priorisoidaan eri tavoin.

Tutkimus tuo uutta tietoa Gur-kielten typologisista ilmiöistä. Samuen kielen kannalta tutkimus on perustavanlaatuinen, sillä se on yksi lähtökohta kielen tallentamiselle ja kirjoitusasun luomiselle. Teoreettiselta kannalta tutkimus osoittaa, että Optimaalisuusteoria on pääosin sovellettavissa kielen koko äännejärjestelmän analysointiin.

Asiasanat: fonologia, toonit, nigeriläis-kongolaiset kielet, Gur-kielet, Optimaalisuusteoria

Dedicated to all Sama people
amongst whom are my dearest Jules and our daughter Kerttu

Bɔnka u kɔɔ na a pu-kanmiya u wɔnaa i yinnima na.

The big lizard said that the good things are eaten with tears.

- Sama proverb -

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List of abbreviations

μ	mora
1p, 2p, 3p	first, second and third person plural
1s, 2s, 3s	first, second and third person singular
adj	adjective
AFF	affirmative
AM	associative marker
ATR	Advanced Tongue Root
C	consonant
CON	connective
COP	copula
DEF	definite
DEM	demonstrative
dep	dependent
Dev	standard deviation
DIM	diminutive
DO	direct object
EXT	verbal extension
F0	fundamental frequency
F1	first formant
F2	second formant
F3	third formant
FUT	future
H	high (tone)
HAB	habitual
Hz	Hertz
IMP	imperative
INDEF	indefinite
IO	indirect object
IPFV	imperfective
ITER	iterative
JUS	jussive
L	low (tone)
lit	literally
M	mid (tone)
N	nasal
NC	nasal-stop sequence
NEG	negation

num	numeral
O	object
OPT	optative
OT	Optimality Theory
p.c.	personal communication
PFV	perfective
pl	plural
pNH	plural non-human
PRES	presentative
PRO	pronoun
PSS	possessive
PST	past
PST.REC	recent past
S	subject
sg	singular
sNH	singular non-human
sp	specific
SPE	the Sound Pattern of English
SUB	subordination
T	tone
TBU	Tone-Bearing Unit
V	vowel
Ø	zero
σ	syllable

List of Optimality Theory constraints employed in the analysis of Samue

Constraints (abbreviation in parentheses)	**Constraint definition**
*#C[-lat]	assign a violation mark for every initial consonant cluster where the second element is [-lateral]
*CODA	assign a violation mark for every syllable final consonant
*COMPLEX, (*COMP)	assign a violation mark for every complex onset consisting of more than one segment
*DISAGREE[back]	assign a violation mark for every instance of opposite [back] value in stem vowels or between stem and suffix vowels
*DISASSOCIATE(H), (*DISASSOC(H))	assign a violation mark for every disassociated H tone
*DISASSOCIATE(H) $< 2\mu$	assign a violation mark in every case of disassociation of a H tone, which is linked to two or more moras
*DISASSOCIATE(H)-1μ	assign a violation mark in every case of disassociation of a H tone, which is linked to a single mora
*DISASSOCIATE(na), (*DISASSOC(na))	assign a violation mark for every occasion when the tone of the particle **nā** is disassociated.
*N_{MED}	assign a violation mark for every word-medial syllabic nasal
*NNN	assign a violation mark for every triple nasal sequence
*NUC/I	assign a violation for every syllable nucleus /i/
*OBS[+voiced], (*OBS[+vcd])	assign a violation mark for every voiced stop
*VVV	assign a violation mark for every tautosyllabic VVV structure
AGREE(C_{PL})	assign a violation mark for two adjacent consonants that do not share the same place feature
AGREE[ATR]	assign a violation mark every time that vowels in a word do not agree in ATR
$AGREE[ATR]_{NOUN}$	assign a violation mark every time that vowels in a noun do not agree in ATR between the stem and the suffix
AGREE[cons]	assign a violation mark for all adjacent consonants in medial position which differ in feature [consonantal]

AGREE[continuant], (AGREE[cont])	assign a violation mark for all adjacent consonants in medial position which differ in feature [continuant]
AGREE[nas]	assign a violation mark for two adjacent consonants that do not share the manner feature [nasal]
AGREE[voice]	assign a violation mark for all adjacent sounds in medial position which differ in feature [voice]
ALIGN-L(na)	assign a violation mark for every instance of the particle **nā** tone whose left edge does not coincide with the left edge of the domain (i.e. the verb stem)
ALIGN-L(pro)	assign a violation mark for every instance of tone of the verb, whose left edge does not coincide with the left edge of the domain (object pronoun + verb)
ALIGN-R(H-noun)	assign a violation mark for every H tone in a noun which does not spread rightwards on the determiner
CODACONDITION, (CODACOND)	assign a violation mark for every coda that is not a nasal homorganic to a following stop
DEP(S)	assign a violation mark for every segment which is epenthesized
DEP(T)	assign a violation mark for every tone which is epenthesized
DEP[-ATR]	assign a violation mark for every [-ATR] occurrence in the output which does not have a correspondent in the input
EXTENDM	assign a violation mark for every leftmost edge of **ntē** M tone that is not extended leftwards, exactly to the preceding TBU in the output
FUT(L)	assign a violation mark for every future tone TBU which does not have L tone
H-ABSORPTION (H-ABS)	assign a violation mark for every rising LH tone in noun, which is followed by a H-toned verb
HIDIPH	assign a violation mark for every diphthong, where the first vowel is [-high]
IDENT(manner)	assign a violation mark for every manner of articulation in the input which does not have an identical correspondent in the output
IDENT(place)	assign a violation mark for every place of articulation in the input which does not have an identical correspondent in the output

IDENT[ant]$_C$, (ID[ant]$_C$)	assign a violation mark for every input-output pair where the input consonant and the output consonant have a different value for the feature [anterior]
IDENT[ATR]$_{stem}$	assign a violation mark for every input vowel in the stem that differs in its [ATR] value in the output
IDENT[back]	assign a violation mark for every instance of output [back] value that does not have identical correspondent in the input
IDENT[cons]	assign a violation mark for every input-output pair where input and output have different values for the feature [consonantal]
IDENT[cont]	assign a violation mark for every input-output pair where input and output have different values for the feature [continuant].
IDENT[-high, -low]	assign a violation mark for every input vowel [-high, -low] (i.e. a mid vowel) which is deleted in the output
IDENT[voice]	assign a violation mark for every input-output pair where input and output have different values for the feature [voice].
IDENT[voice]$_{mi}$	assign a violation mark for every morpheme initial consonant which has a different value in [voice] between input and output
IDENTONSPL	assign a violation mark for every onset consonant in the input that has a different place in the output
IDENT-T	assign a violation mark for every input tone which does not have a correspondent in the output
IDENT-T(noun1)	assign a violation mark for every first compound constituent whose lexical tone is not identical between input and output
IDENTV2	assign a violation mark for every input vowel V2 of the vowel sequence which does not have an identical correspondent in the output
IPFV(M)	assign a violation mark for every imperfective verb TBU which does not have a M tone
LOCAL	assign a violation mark for every instance of tone spreading which is not limited to the adjacent elements
MAX(↑)$_{gr}$	assign a violation mark for every grammatical input vowel [+high], [+ATR] which is not realized in the output
MAX(↓)$_{lex}$	assign a violation mark for every lexical input vowel [low], [-ATR], [-high] which is not realized in the output

MAX(↔)$_{gr}$	assign a violation mark every grammatical input vowel [-back], [round] which is not realized in the output
MAX(↔)$_{lex}$	assign a violation mark for every lexical input vowel [-back], [round] which is not realized in the output
MAX(H)	assign a violation mark for every input tone H which does not have a correspondent in the output
MAX(H,H)	assign a violation mark for every input sequence of two H tones which does not have correspondent in the output
MAX(L)	assign a violation mark for every L input tone which does not have a correspondent in the output
MAX(S)	assign a violation mark for every input segment which is deleted in the output
MAX[-ATR]	assign a violation mark for every [-ATR] occurrence in the input which does not have a correspondent in the output
MAX[front]	assign a violation mark for every input vowel [+front] which is deleted in the output
MAX[i,u]	assign a violation mark for every input [+high] vowel which does not have a correspondent in the output
MAX[nas]	assign a violation mark for every nasal consonant in the input which is not realized in the output
MAX-BR(T)	assign a violation mark for every base tone that does not have a correspondent in the reduplicant
MAX-IO(T)	assign a violation mark for every input tone that does not have a correspondent in the output
MAX-T(Lex)	assign a violation mark for every lexical input tone which is not realized in the output
MAX-T(noun2)	assign a violation mark for every output occurrence of the last compound constituent, if noun, which does not have LH tone
MAXV	assign a violation mark for every input vowel which does not have a correspondent in the output
MORAFAITH	if the number of moras linked to S_i = n, and S_iRS_o, then the number of moras linked to S_o = n (Broselow et al. 1997, their (28))
NODIPHTHONG, (NODIPH)	assign a violation mark for every tautosyllabic diphthong

NoLongT	assign a violation mark for every tone associated with more than one TBU
NoSharedMora	moras should be linked to single segments (Broselow et al. 1997, their (27b))
OneT/μ	assign a violation mark for every single mora that has more than one tone associated with it
Onset, (Ons)	assign a violation mark for every syllable which does not have an onset
Pal-i-[-high]	assign a violation mark for every coronal fricative [+anterior] which is adjacent to a front vowel [-anterior] followed by [-high] vowel
SyllBin	syllable weight should not exceed two moras (Broselow et al. 1997, their (27a))

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Soli Deo Gloria. To God alone be the glory.

Turku, May 2015
Virpi Ouattara

1 INTRODUCTION

1.1 Background

The topic of the present thesis is the analysis of the phonological and tonal structure of an undescribed minority language called Samue, which is spoken in Burkina Faso, West Africa. If the linguistic analysis of languages is driven solely by academic objectives, the analysis of an undocumented language may give evidence about language affinities and also provide more confirmation about universals (or rare phenomena) for language typology. When taking into consideration also the language speakers, a general purpose of analyzing an undocumented language has somewhat wider ambitions in supporting the linguistic community in keeping their language vital, and also empowering people to value their languages.

The Samue language is a minority language that has stayed largely undescribed to date. This is still the case for many minority languages spoken by a small number of people around the world. Some of these languages are still vigorous, whereas others are having difficulty keeping their vitality in an oral form because of the sociolinguistic changes and multilingual environment. Thus, language documentation may help to preserve the language, and the language description along with the orthography development is a helpful tool in reinforcing the linguistic and cultural identity of people.

The purpose of the present thesis is to analyze the phonological and tonal system of one such language. While the sound system is only one part of the linguistic structure of a language, it is, however, the starting point for the linguistic description and further development of the language. The examination of phonological processes demands also the analysis of basic morphological structures, as many phonological phenomena are in reality morphophonological. Consequently, the basic morphological structure of the Samue language is also described, while the main objective is on the phonological and tonal analysis of the language.

1.2 Research questions and hypothesis

The research questions are twofold. The first objective is to analyze the segmental sound system of the Samue language. This includes several sub-sections, such as how many consonant and

vowel phonemes occur in the phonological system and what are the main acoustic realizations of these basic units that differentiate meaning. What are the allophones of the phonemes, and in which environments do each of these allophones occur? In addition, the phonological processes occurring in the sound system are described and analyzed. Phonotactic phenomena are examined in order to describe syllable structures and the restrictions of the co-occurrence of different phonemes. Secondly, the tonal structure of the language is investigated. The objective is to examine how many lexical level tones are present in the language, and how these level tones are realized acoustically. Tonal alternations in word and sentence levels are also analyzed; this will reveal the tonal processes of the language. In addition to the lexical meaning of tones, the grammatical function of tones is also discussed.

The present study will give valuable information on the sound system of Samue in relation to the phonological and tonal structures found in other languages of the same language family, namely the Gur languages of the large Niger-Congo phylum. The language classification is studied in detail in section 2.1 below. The hypothesis is that the phonological and tonal structures of Samue have several equivalences with other Gur languages, for example the places of articulation attested in the language or the tonal processes the language displays. However, the present study analyzes a previously largely undescribed language, and thus, there may be surprising or unexpected outcomes.

1.3 Theoretical approach

The theoretical approach applied in the present study is Optimality Theory (Prince & Smolensky 1993/2002). It was developed as a response to linear phonology (see more in chapter 5), which was seen as an inadequate model in explaining all phonological processes. When describing a previously undocumented language, the description alone gives further insights into language affinities and typological situations. However, language description is only the first step in the linguistic analysis; i.e. a description demands an explanation for the phenomena attested in the language. In the present study, the analysis is done according to the Optimality Theoretic principles. The application of the Optimality Theory in the present study can be considered as not only a theoretic formulation, but rather a methodological approach to the language data.

Optimality Theory has been chosen as the theoretical framework because of its renewed look at the language. All theories have their restrictions, but Optimality Theory is largely applicable to all domains of phonological and tonal analysis. The basic principle of violable constraints is a powerful tool for analyzing different elements of the language, as many phenomena called universals may actually not be universals. The so-called universal processes are applied

differently in the languages of the world, and thus, the Optimality Theory provides a framework for handling these situations, as the language differences are analyzed as a result of the different ranking hierarchies of the universal constraints. Optimality Theory in its very nature is typological, and therefore it predicts the factorial typology of the constraint rankings (see more in 5.2.6). Consequently, some very basic phonetic factors that affect sonority, for example, can be explained by ranking the segments of different sonority categories. This applies, for instance, to the syncope process that has been analyzed as a phenomenon linked to stress, but which also exists in tone languages without an overt stress (see more details in 6.4.4).

Optimality Theory is often applied to certain phonological phenomena of a language, or a particular process in several languages is analyzed within Optimality Theory. However, the thorough phonological analysis of a whole language system using Optimality Theoretic principles is still very rare. Cahill's (2007a) analysis of Kɔnni is a remarkable exception. Thus, one of the objectives of the present study is to examine, how easily the application of this specific theoretical framework suits the description of the whole domain of a particular language, which in the present case is previously undocumented.

1.4 Transcription and data

The transcription of Samue data is phonological in Chapter 3, which concentrates on the morphology of the language. In phonological analysis, the transcription is often given both phonetically in square brackets, [], and phonologically in slashes, //. Phonemic tone is transcribed by accents: acute accent for high (á), macron for mid (ā), and grave accent for low tone (à). Contour tones are marked by a combination of levels, e.g. /ă/ denotes a rise from low to high, and /ā̀/ denotes a fall from mid to low. Sometimes the phonetic realization of tone levels is given in square brackets. A lowered high tone, or downstep, is marked by down arrow superscript (ꜜ) before the downstepped syllable.

The examples in Samue are translated into English, and normally a basic meaning is given for each verb, although especially verbs have several sub-meanings. Moreover, because of the phonological nature of the present study, the semantic details of nouns are not looked for. Thus, especially the lexemes of flora and fauna are often translated with a general reference, i.e. *bird* (sp), referring to a specific species of bird. More details of the data and the data collection are given in section 2.4 below.

1.5 Outline of the thesis

The present study is outlined in the following manner. First, Chapter 2 describes the language classification, earlier research done in Samue, and the data collection process. Chapter 3 gives a brief sketch of the Samue grammar, including the main morphological structures of the nouns and verbs. The grammar sketch does not cover the whole language in detail, because the focus of the present study is on the phonological and tonal structure of the language. The basic grammatical and morphological phenomena are described, however, in order to enable a better understanding of the subsequent sections dealing with the sound system of the language.

Chapters 4 and 5 represent more theoretical approaches. Chapter 4 concentrates on the phonological and tonal phenomena found in the Niger-Congo languages and in the Gur language family particularly, whereas Chapter 5 is the main theoretical chapter introducing the principles of the Optimality Theory. The background of the Optimality Theory is briefly discussed in 5.1 before describing the core of the theory in 5.2. The subsequent sections 5.3 and 5.4 present an overview of the Optimality Theoretic applications employed in phonological and tonal analysis.

The main chapters of the description and analysis of the Samue sound structure are Chapters 6 and 7. Chapter 6 presents the analysis of consonant (section 6.1) and vowel phonemes (section 6.2), as well as phonotactic features of the language in section 6.3. Section 6.4 describes and analyzes the phonological processes of the Samue language. Chapter 7 concentrates on the study of the tones. First, contrastive tones and tone bearing units are discussed in section 7.1. In the subsequent sections, tone in noun and noun phrases as well as in other complex forms (section 7.1) and tone in verb and verb phrases (section 7.3) are examined separately. Section 7.4 gives an overview of the tonal processes of pronouns. The main contributions of the present study are concluded in Chapter 8.

2 LANGUAGE DESCRIPTION

The objective of the present study is to provide a phonological and tonal analysis of the Samue language. In this chapter, the Samue language is described from general perspectives. These include the localization of the language area and a typological classification of the language. Furthermore, the dialectal situation is briefly discussed before reviewing the few studies conducted on Samue. The chapter ends by describing the data collection phase, including the amount of data, language informants, and recording procedures.

2.1 Localisation and classification

The Samue language (pronounced [sə̆múé]) is a minority language spoken in south-western Burkina Faso (in the district of Loumana, a province of Léraba) near to the border of Mali (see Figure 1). The number of speakers was about 5 500 in 1996 (Sawadogo 1997/2006), but the estimation of the population varies (see e.g. Winkelmann 2007a). If the population growth rate is considered, it may be possible that the number of Samue speakers is now actually around 9000[1].

Samue speaking people call themselves Sama (plural form, Sə̆mnĭ in singular). The language and the people group are called Wara by outsiders; this name often appears in the literature. Wara means 'wild animal' in Dioula, a trade language used in the region, and it can be considered as derogatory. In this study, the native name Samue is used and written as in the actual Samue orthography.

Sama live in the small area of 190 km^2 that includes the following five villages: Klani, Néguéni, Niansogoni, Outourou and Sourani (see Figure 2). Faniagara village (marked by a small circle in Figure 2) is isolated from the other Sama villages, although the inhabitants of Faniagara are considered a part of the Sama ethnic group. The Samue dialect spoken in Faniagara is called Palɛni and it has diverged from the Samue spoken in other villages. It may be considered as a language of its own (Winkelmann 2007b, Sawadogo 1997/2006).

[1] Population growth rate in Burkina Faso was 2.68 % in 1993 (Laclavere 1993) and 3.1% in 2006 (ISDN, Institut National de la Statistique et de la Démographie).

Figure 1. Samue speaking area in Burkina Faso (modified from Sawadogo 1997/2006).

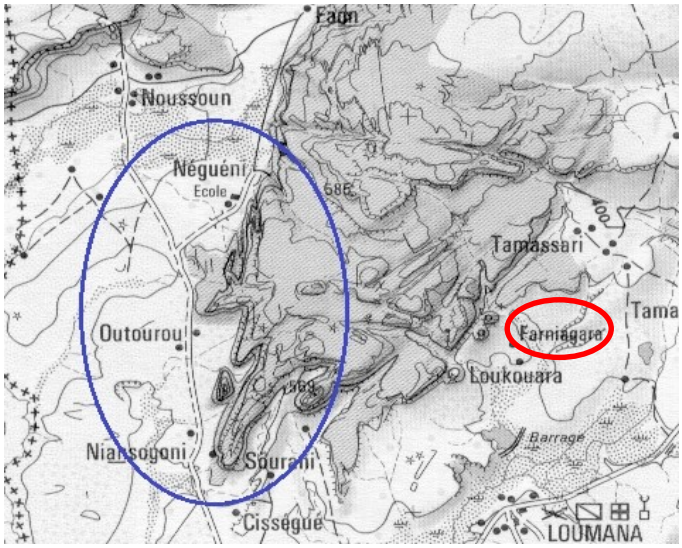


Figure 2. Samue speaking villages (modified from Institut Géographic National 1975:feuille NC-30-XII).

Samue is part of the **Gur subgroup** of the large **Niger-Congo language phylum**. There are about a hundred Gur languages and they are located primarily within the basin of the Volta River. For that reason these languages are sometimes called voltaic, especially in French (*langues voltaïques*) (Williamson & Blench 2000). Their location includes regions of Mali and Ivory

Coast, a large part of Burkina Faso, northern parts of Ghana, Togo and Benin, respectively, and some parts of Nigeria (Naden 1989). The classification of the Gur subgroup in the Niger-Congo family is illustrated in Figure 3 according to Williamson (1989); Lewis, Simons & Fennig (2013) follow the same classification sketch. Williamson and Blench (2000) give a slightly modified family tree of Niger-Congo with some further divisions, e.g. in Adamawa and Benue-Congo subgroups. It seems that a continuum relation exists between Gur and Adamawa-Ubangi.

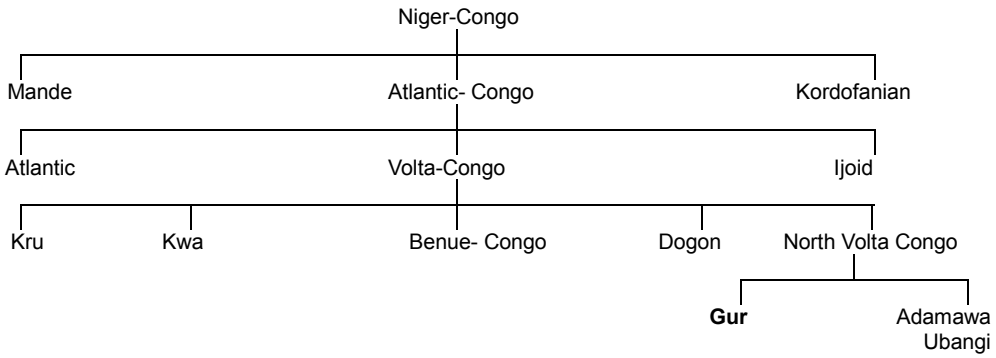


Figure 3. Niger-Congo classification according to Williamson (1989).

Among the Gur languages, the **Central Gur languages** form two groups of quite closely related languages, namely south and north (see Figure 4 for a simplified sketch of Gur language classification, modified from Naden 1989, which differs slightly from Williamson & Blench (2000)). **Senoufo languages** among themselves also represent a group of related languages, although not convincingly Gur (Williamson & Blench 2000). The remaining subgroups of the Gur languages are peripheral and not closely related to the other Gur languages (ibid.).

The classification of Samue is the following: Niger-Congo, Atlantic-Congo, Volta-Congo, North, Gur, Wara-Natioro, Wara (Lewis et al. 2013). The nearest genetic relative to Samue is Natioro (Prost 1968). Together they form the **Wara-Natioro subgroup** of Gur languages, **which is unclassified in relation to other Gur languages** (Williamson & Blench 2000). Samue, Natioro and Palɛni are also considered to form a Samu-group according to Winkelmann (2007b). According to Naden (1989), Samue is an improbable central Gur language. Earlier, Wara was even referred to as a member of the Senoufo subgroup of Gur languages, although without confirmation (Westermann & Bryan 1952). Winkelmann (2007b:561) is not convinced that the Wara-Natioro group is be closely related to central Gur languages, at least with regards to the noun class system in these languages. Samue has the main characteristics of the Gur languages as presented by Naden (1989), e.g. noun class system by suffixes, grammatical tone, vowel harmony and aspectual (perfective vs. imperfective) verb forms. Samue is geographically

surrounded by other Gur languages, namely Sicité Senoufo, Senara Senoufo and Natioro (see also Figure 1).

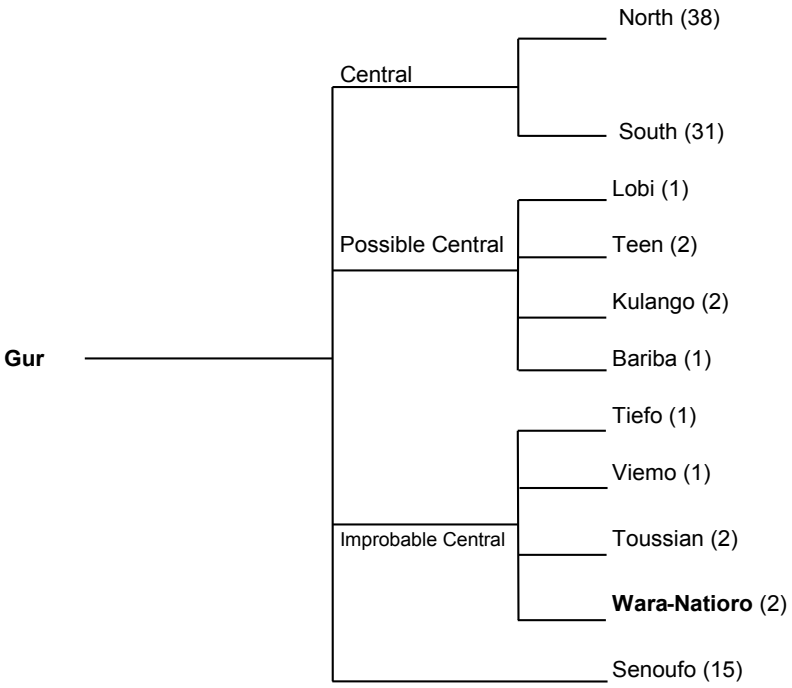


Figure 4. Gur language classification modified from Naden (1989). The number of languages of each subgroup in brackets (according to Lewis et al. 2013).

2.2 Dialectal and sociolinguistic situation

Researchers are not unanimous about the number of dialects. According to Sawadogo (1997/2006), Samue has two main dialects: the northern dialect of Néguéni, Klani and Outourou villages, and the southern dialect spoken in Niansogoni and Sourani. In the present study, Sourani speakers are considered as having a southern dialect of their own, and Niansogoni is considered as a central dialect between north and south. The Outourou dialect has characteristics of both northern (Néguéni and Klani) and central (Niansogoni) dialects. Winkelmann (2007a) also makes the distinction between three different dialects. The dialectal classification used in the present study is based on the dialectal survey (Kalliorinne 2012c) I conducted during the fieldwork period (see 2.4). Comprehension between all these dialects is good.

The Samue language is spoken in everyday life among the Sama. Language contacts occur at the meeting points (e.g. markets) with other ethnic groups. Dioula is used as a *lingua franca*, and many adults also speak the Senara Senoufo language, a language of the adjacent ethnic group.

The Sama have contacts with the Senoufo, Natioro, Dioula, Bambara, Samogho, Blé, Noumou and Jowulu ethnic groups, among others (Sawadogo 1997/2006). Some of their languages belong to the Gur subgroup, others to the Mande subgroup of Niger-Congo languages (e.g. Dioula, Bambara, Samogho). Sama children learn French at school, but use Samue in everyday life. Until recently, there was no orthography or any written material in Samue. Experimental orthography (Kalliorinne 2012a) has been developed and some materials (e.g. Kalliorinne & Ouattara 2012) are published in Samue in order to reinforce the use of the language also in the written form and to enable culture and language preservation.

2.3 Earlier research

Few studies have been conducted in Samue. In the 1930s, Tauxier (1939) conducted anthropological research among the Sama and collected a wordlist of 600 words. Prost (1968) made a short description of the Samue phonology and grammar that includes only one mention of a tonal system. His study is based on the Néguéni dialect of Samue. Winkelmann (2007a) conducted research on the Samue noun classes making an "impressionistic" transcription, because the phonology and tonology of Samue were not analyzed. Apart from these studies and an unpublished sociolinguistic survey report (Sawadogo 1996/2007), as well as an unpublished grammar sketch (Kalliorinne 2012b), any detailed analysis of the language has not been done to date.

Research into Gur language phonologies and tonal systems in general has been conducted only partially and many languages still lack a detailed description (Naden 1989). Cahill (2007a) gives a quite comprehensive list of Gur language publications that include books, articles, and dissertations or theses.

2.4 Data collection

All the data used in this study was collected in the Samue speaking village called Niansogoni, during a **fieldwork period** of three years, from February 2010 to January 2013. Most of this time was spent in the village collecting the data, analyzing the language, and also speaking it with the people. In that sense the study is conducted *in situ* conditions.

The village of Niansogoni was chosen because of the sociolinguistic survey (Sawadogo 1997/2006) that showed that the dialect spoken in Niansogoni is the dialect which is best understood by other Samue speaking people. This fact is important when developing orthography.

Because the orthography development of the language was in focus, the linguistic analysis including the phonological and tonal analysis was also conducted in that same village. This dissertation is thus based on the Samue spoken in Niansogoni, but some phonological phenomena that are considerably divergent between dialects will also be mentioned.

2.4.1 Linguistic corpus and informants

The linguistic corpus used in this study includes 1800 lexical items (1100 nouns, 430 verbs and words of other parts of speech), thousands of elicited sentences, and 30 oral texts. The average length of texts is 500 words, having a variation between 119 and 1234 words. Several language informants participated in the study. Most of the **lexemes** were collected from one language informant, but in the process of elaborating the lexicon for publishing, all the words and their pronunciations were checked by two native speakers. A **short wordlist** of 53 words with two repetitions of each word was collected from 11 persons. Six of the eleven informants were female. This wordlist is used for the acoustical analysis of Samue phonemes. The **elicited sentences** include some conversational sentences that contain everyday vocabulary. A major part of the elicited sentences consists of sentences where different kinds of grammatical phenomena are studied. The elicited sentences also include frame sentences for tonal analysis. **Oral texts** consist of narrative materials which were collected by interview or by free talking, e.g. the informant told a traditional fairytale or a historical story. Some texts are process descriptions. Texts were collected from ten different informants; one of them was female, the others were men. The sentences together with texts are especially used for analyzing the phonological and tonal processes.

All the informants were **native speakers** of Samue, who live in Niansogoni. The **main language informant** used for data collection was a young man, who was 20 years old at the beginning of the fieldwork period. He had lived his whole life in Niansogoni, except for the two years that he spent in a Senoufo speaking village where he went to elementary school. He speaks fluent French and Dioula and some Senoufo. All the language informants were bilinguals in Dioula and/or in Senoufo to some extent. A few of them spoke French, depending on how many years of education they received. It is basically impossible to find monolingual informants; some elderly ladies (from 65 years onwards) spoke only Samue, but they were not ideal language informants, e.g. for health reasons. The age of informants varied from 20 years to about 60 years. The aim was to have a complete picture of the language; for that reason informants cover an age range from young adults to elderly speakers.

2.4.2 Recording and data analysis

All the data were recorded with a portable digital recorder Zoom H4n (with a sampling rate of 44.1 kHz with 16-bit resolution). Recordings of wordlists and sentences were made in .wav format. A condenser microphone (AKG C 1000 S) was used for recording the isolated words and sentences from the main informant, but the wordlist collected from 11 persons was recorded with the device's inbuilt microphones due to the portability problems around the village. For recording of oral texts, the device's inbuilt microphones were used and recording was made in .mp3 format. Recordings were done in the village in natural settings, e.g. in the open air in courtyards or inside the tin roofed huts.

The data were first transcribed phonetically. The phonetically transcribed words were fed to Fieldworks 6.0 Language Explorer-database, version 3.0.0, (© SIL, available on http://fieldworks.sil.org/flex/), from where they were exported to Phonology Assistant 3.3.3 (© SIL, available on the http://phonologyassistant.sil.org), which is a tool for facilitating phonological analysis.

The **acoustical analysis** was done with Praat (Boersma & Weenick 2013). For vowels, formant values F1, F2 and F3 were extracted at the midpoint of the vowel, which is normally the steady-state phase. The segment duration was also measured and it was done by scripts[2]. Formant value measurements were also done mainly by scripts in Praat, but especially with male speakers, formant values for /u/ and also for /o/ were measured manually by spectral view at the midpoint of the vowel for the period of 50 ms; this was because the automatic measurement was not able to extract F1 and F2 formants separately. Formant measurement in Praat is based on the LPC analysis with the Burg algorithm using a Gaussian-like window.

An extracted pitch contour was used in order to determine the fundamental frequency (F0) values for tonal analysis. F0 was measured for every Tone-Bearing Unit in utterances that were analyzed. The principles used by Connell and Ladd (1990) were applied. In the case of unchanging F0 over several syllables, F0 was easily determined. In the case of clear F0 peaks and valleys in the sequences where a high and a low alternate, F0 was measured at the peak for the high tone, and at the valley for the low tone. Pitch perturbations after consonants were ignored, and F0 was measured in the level of a 'shoulder', a short stable level. In rising or falling tones, starting points and endpoints of the contour were measured at the level of the shoulder, if it was present. If no shoulder could be determined, the level of the energy peak was used as a basis for the F0 measurement.

[2] Scripts used were provided by Mietta Lennes, http://www.helsinki.fi/~lennes/praat-scripts/

3 GRAMMAR SKETCH

The focus of the present study is on the phonological and tonal system of Samue. In order to be able to explicitly analyze a tonal system, some fundamentals of grammar are discussed in this chapter. In the next chapter, the phonological and tonal characteristics of the Niger-Congo and especially the Gur languages are discussed. This chapter outlines basic morphological structures of nouns and verbs, and also the characteristics of noun phrases and verb phrases are examined. The morphology of pronouns is also discussed. This presentation of grammar is based on the research I conducted during the fieldwork period (Kalliorinne 2012b); references to Prost's (1968) description are made, when applicable.

Samue has a Subject-Object-Verb (SOV) word order in the imperfective aspect (1), but SVO order in the perfective aspect (2)[3]. Senoufo languages have an SOV order (Watters 2000), whereas the main Gur languages normally have an SVO order (Williamson & Blench 2000). Objects in SOV order in Samue are always the direct objects; the indirect object is positioned after the verb (3). Prost (1968) considers this change of the direct object's placement as a particularity of Samue.

(1)

Píl-bé	ì	lúúpí-é	ú	cēē-kēē	nā.
child-sg	3s	bird-sg	sNH.DO	look.at-IPFV	AFF

The child is looking at the bird.

(2)

Píl-bé	ì	cé	lúúpí-é	nā.
child-sg	3s	look.at(PFV)	bird-SG	AFF

The child looked at the bird.

(3)

Píl-bé	ì	mān-nēē	ísēē	nā.
child-sg	3s	talk-IPFV	3s.IO	AFF

The child is talking to him.

[3] Future tense has the SOV order, whereas other modalities follow the PFV vs. the IPFV forms of the verb, e.g. jussive has the PFV verb form, and thus the SVO order (see 3.4.2 Tense, aspect and mood).

3.1 Nominal morphology

Lexical items are polymorphemic in Samue, as they consist of stems and suffixes; e.g. nouns consist of lexical stems and noun class suffixes (the word structure of nouns is discussed in detail with syllable structures 6.3.1.1). The **noun root** is demonstrated most clearly in the plural, because sometimes the stem encounters vowel modifications between singular and plural. It is the stem used in the plural that is considered the root, and it is also attested in noun complexes (4). In cases where the modification occurs with the singular suffix **-a**, as in the example (4), Winkelmann (2007a:314-315) considers the stem vowel to be assimilated into the singular suffix. If this hypothesis is correct, the input form for *hut* (4) is /bɔ́-à/ and it produces the output form [báà] by assimilation (see 6.4.3 for vowel coalescence).

(4)	a) báà	b) bɔ́ɔ̀-mă	c) bɔ́ɔ̀-kpĕ
	hut, sg	*huts, pl*	*hut-big (sg)*

In Samue, as in the Gur languages in general (Naden 1989), nouns are characterized by **noun classes**, which determine the singular and plural forms. Seven singular suffixes, plus the zero singular suffix, and six plural suffixes occur in Samue. Except for the classes restricted to human designation, singular suffixes may be combined with nearly all plural suffixes (all the possible pairings are shown in Figure 5). The noun class system in Samue can be called irregular in contrast to those languages where a particular singular-plural suffix pairing always forms one gender, and where the pairings cannot be mixed. For example, Kassem spoken in Ghana and Burkina Faso (Callow 1966) is such a language where the pairings are regular. Winkelmann (2007a) tried to reconstruct Samue noun class system in relation to the Proto Gur system using traditional numbering. However, in the present study the numbering of noun classes is not used, because the focus is not on the restructuring, and also because the pairings are very irregular.

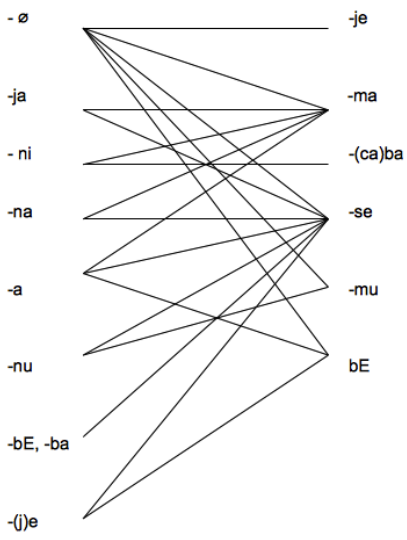


Figure 5. Pairs of singular (on the left) and plural (on the right) suffixes.

Winkelmann (2007a) did not make a distinction between **-nu** and **-ni** singular suffixes. In the present study, they are considered distinct, because **-ni** is used only when referring to humans. It is true, however, that the **-nu/-mu** pairing is pronounced with a front vowel [**-ni/-mi**] in Néguéni dialect. Otherwise, the singular suffixes of Winkelmann (2007a) conform to the classification used in this study. Within plural suffixes, Winkelmann (ibid.) does not consider -**ba** as a separate class, and the author also posits the suffix -**e**, which is very rarely used however. Only two lexemes are found in my database that use -**e** to mark the plural (**sămúé**, *Samue language* and **námúé**, *meat* in plural). Prost's (1968) classification of noun classes is based on the plural suffixes that he considered to be only three: 1) **-ma** or **-mi**, 2) **-se** or **-si** and 3) **-be** or **-bɛ**.

Examples of the most frequent noun class suffix combinations are given below (5). The suffix is separated by a hyphen. The first four examples refer to humans, singular suffixes **-ja** and **-ni** and plural suffixes **-je** and **-ba** being specific to human reference. The tone of the suffix is dependent upon the tone of the stem. After a stem ending with a low tone, the suffix has a contour tone low-high. If the stem ends with a mid or high tone, the suffix is high. There is an exception with the classes **-ba/-se**, as the tone of the stem changes between the singular and the plural (**nàà-bă**, *cattle*, **náá-sĕ**, *cattles*, see also the example **cìì-bă**, *cricket*, below), see more in 7.2.1.

(5) Examples of the most frequent combinations of singular and plural suffixes

Suffixes	**Singular**	*Gloss*	**Plural**	*Gloss*
Humans				
-ja/-ma	**ɪ́túú-já**	*blind person*	**ɪ́túú-má**	*blind people*
-ni/-ma	**fŭn-ní**	*blacksmith*	**fùú-má**	*blacksmiths*
∅/-je	**púɔ́**	*husband*	**púɔ́-jé**	*husbands*
-ni/-ba	**túcà-nĭ**	*stranger*	**túcà-bă**	*strangers*
Non-humans				
-na/-ma	**jɛ̀ɾè-nă**	*carp*	**jɛ̀ɾè-mă**	*carps*
-a/-ma	**kū-á**	*calabash*	**kūū-má**	*calabashes*
-ba/-se	**cìì-bă**	*cricket*	**cíí-sè**	*crickets*
-na/-se	**cāɪ́-ná**	*lion*	**cāɪ́-sé**	*lions*
-nu/-mu	**kúú-nú**	*crocodile*	**kúú-mú**	*crocodiles*
-a/-bɛ	**tú-à**	*baobab*	**túò-bɛ̆**	*baobabs*
∅/-bɛ	**bàɾă-**∅	*bat*	**bàɾà-bɛ̆**	*bats*
-e/-be	**sì-é**	*tree*	**sìì-bĕ**	*trees*

In Samue, **the pronoun concord system** (6) is reduced to human versus non-human marking on pronouns, i.e. there are no distinctive concords for all noun classes. Concord is different for non-humans according to aspect, imperfective (IPFV) or perfective (PFV). After a nominal subject or object, a concord pronoun (glossed by 3s or 3p for humans, and sNH or pNH for non-humans) always follows the noun (see examples (7) and (8)), while ***Písé pēē nā** (*children come*) without a concord is not a grammatically acceptable construction. The concord element is called "*pronom de rappel*" [reminder pronoun] by Prost (1968:16), and it could also be called the definite article. According to Prost (1968), however, the concord pronoun is used only after the demonstrative. He states that in other contexts the noun has a specific form ending with vowels /u/, /o/, /ɔ/ or /ɛ/. I have found that the final vowel of the noun and the following vowel of the pronoun merge, i.e. the pronouns consisting of a sole vowel, as **ù** and **ì**. This vowel coalescence is common in the language (see also (11) and 6.4.3) and gives the vowel qualities that Prost (1968) considered as specific forms. Concord pronouns are also used alone as personal pronouns (see 3.6 below).

(6) Concord pronouns for non-humans (NH) and humans

	NH IPFV	NH PFV	human
Sg	kì	ù	ì
Pl	ǹtì	ǹ	pì

(7) Pí-sé pì pēē na.
child-pl 3p come(IPVF) AFF
Children are coming.

(8) Kūū-má ntì nā kúà.
calabash-pl pNH AFF empty
Calabashes are empty.

Indefiniteness is marked in Samue by an indefinite determiner (9) that can also be used as an indefinite pronoun. If the indefinite determiner is not attested, the concord pronoun is always attested after a nominal subject (10) or a nominal direct object in the imperfective (11). The concord pronoun does not distinctly mark referentiality, but its absence calls for the presence of an indefinite element. The structure with a concord pronoun is much more frequent in the textual corpus collected than the structure with an indefinite pronoun.

(9) Kpíí-jé **ńkpélébé** pā nā.
man-sg INDEF.sg come(PFV) AFF
A man came.

(10) Kpíí-jé **ì** pā nā.
man-sg 3s come(PFV) AFF
The man came.

(11) ì lúúpí-é **ú** cēē-kēē nā.
3s bird-sg 3s look.at-IPFV AFF
He is looking at the bird.

3.2 Noun phrase

In an **associative noun phrase**, the dependent noun precedes the head noun and it is followed by an associative marker (AM), which agrees with the dependent noun, as illustrated in (12) to (15). The associative marker is **í** in singular and **ú** in plural for humans, and **ú** in singular and **ń** in plural for non-humans. According to Prost (1968), a specific form of the noun, ending with

vowels /u/, /o/ or /ɔ/, is used in an associative phrase. This form Prost mentions may be due to the vowel coalescence in pronunciation when the vowel **í** and **ú** of the AM are in contact with vowel ending nouns (see also 3.1). For example in (14), /e/ and /u/ are fused to [oo] in /sìé ú kóó/ (*the trunk of the tree*), see also (12) and (13). This fusion occurs in Samue in other contexts as well (see more explanation in chapter 6.4.3).

(12) fī-á í báà Pronounced [fiɛ́ɛ́ báà]
small.brother-sg AM(3s) hut
hut of the small brother

(13) bɔ́ɔ́-má ú bāā-má Pronounced [bɔ́ɔ́mɔ́ɔ́ bāāmá]
classmate-pl AM(3p) sheep-pl
classmates' sheep

(14) sì-é ú kóó Pronounced [sìòō kóó]
tree-sg AM(sNH) head
trunk of the tree

(15) kā́kā̄-má ń wā́ā́
ant-pl AM(pNH) road
ants' road

In complex structures with an adjective or numeral, a bare noun stem is followed by an adjective or a numeral to which the class suffix is added, as Prost (1968) also mentions. In some cases the numeral is added after the noun which keeps its plural suffix; in these cases the plural suffixes are not attached to the numeral, but only to the noun stem (16). In the case of number one, the noun stem is followed by the number and the singular suffix (16). The only demonstrative **nì** is always in the last position, and the possessive pronoun in the first (17). Noun phrase constituant order is the following:

PRO.PSS+ (dep.Noun+AM+) **head**-num/adj-sg/pl-DEM

(16) a) bɔ́ɔ̀-mă tíí b) bɔ́ɔ̀-pō-nŭ
hut-pl three hut-one-sg
three huts *one hut*

(17) ǹ kū-kpè-tíí-mú-nī
1s.PSS calabash-big-three-pl-DEM
these three big calabashes of mine

3.3 Derivations and compound words

Derivation is done mainly by suffixes. Nouns can be derived from other nouns or from verbs. Some examples are given below in (18). The derivational suffixes can serve, for example, as a semantic operator of possession, of agent, of instrument, of diminutive, or they may express the meanings like 'inhabitant of place x', 'having the quality x'. The tonal behavior of the derivational words is discussed in 7.2.3.

(18)

bóókò-sùbě	*village chief (village-owner)*	**bóókò-sììsě**	*chiefs*
cíī-fù-sùbě	*single (woman-without-owner)*	**cíī-fù-sììsě**	*singles*
jǎjí-nǐ	*visitor (visit-agent)*	**jǎjí-càbă**	*visitors*
bānfórā-nì	*inhabitant of Banfora*	**bānfórā-càbă**	*inhabitants of B*
kèèlè-kù-já	*shepherd (flock-tend-agent)*	**kèèlè-kù-má**	*shepherds*
ítúú-já	*blind person* (ítúú-jé *blindness*)	**ítúú-má**	*blind people*
kàllì-kă	*ladder* (*climb-thing*)	**kàllì-kpă**	*ladders*
pìllì-kă	*broom* (*sweep-thing*)	**pìllì-kpă**	*brooms*
jìbìn-pié	*piglet (pig-DIM)*	**jìbìn-pìsé**	*piglets*

The noun **ka**, *a thing*, determines the characteristics of things, and forms new nouns from stative or inchoative verbs (19), adjectives or numerals (20). These words could also be analyzed as compounds.

(19) Kì nā kà-lǎ̀mì-nà.
sNH COP thing-long-sg
It is long (lit. it is a long thing).

(20) Tì pā nā tí kà-tíí-mú.
1p come(PFV) AFF 1p.PSS thing-3-pl
We came, we three.

Compound words consist of a noun stem and another lexical item, which together function as a noun. The following types of compound nouns are possible in Samue: noun-noun, noun-verb, and verb-noun. Noun-noun compounds are the result of joining two or more noun stems together to make a complex noun (21). The class suffix is that of the last word. The first noun loses its class suffix, except for **-na** or **-nu**, where it loses only the final vowel. In (21), the hyphen in the

compound noun marks the boundary of the two nouns. In simple words it marks the noun class suffix. Compound nouns differ from the associative noun phrases in which both nouns keep their class suffixes. In associative noun phrases the meaning is also different. Tonal behavior in compounds is discussed in section 7.2.2.

(21)

Compound noun	*Gloss*	**1st noun**	*Gloss*	**2nd noun**	*Gloss*
jíì-bàá	*bladder*	**jíì-mŭ**	*urine*	**báà**	*hut, house*
ná-wùlòmŭ	*milk*	**náá-sĕ**	*cattle*	**wúló-mú**	*breast*
pán-tìé	*footprint*	**pā́-ná**	*foot*	**tì-é**	*place, spot*
lóón-wīǐjă	*line*	**lóó-nú**	*fishing rod*	**wī́ī-já**	*rope*

In noun-verb compounds, the noun stem and the verb in citation form are put together. The citation form of the verb has the noun class suffix **-na/-ma** or **-nu/-mu,** if the verb has a verbal extension, as **sí**[4] in **máájìrìkèsíná**, *earthquake* (see examples in (22)).

(22)

Compound noun	*Gloss*	**Noun**	*Gloss*	**Verb in citation form**	*Gloss*
kènú-fèé	*prayer*	**kènú**	*God*	**fèé**	*to greet*
kúsù-fɛ̀ɛ́	*abortion*	**kúsŭ**	*pregnancy*	**fɛ́ɛ́ (PFV)**	*to take out*
wīn-jēsīēná	*chagrin*	**wīī-ná**	*interior*	**jésíé**	*to spoil, to harm*
máájìrìkèsíná	*earthquake*	**máá**	*soil*	**jìrìkèsíná**	*to tremble*
wīn-kānmīēná	*joy*	**wīī-ná**	*interior*	**kánmílé**	*to be good*
tɛ́ɛ́nwààsĕ	*forgetting*	**tɛ́ɛ́-ná**	*conscience*	**wààsĕ**	*to lose*

In verb-noun compounds (see (23)), the verb is in a form marked by **-ni**; it is a gerundive and participle form of the verb. The compound has the original noun class suffix of the noun.

(23)

Compound noun	*Gloss*	**Verb FUT**	*Gloss*	**Noun**	*Gloss*
sùùnì-bàá	*boutique, shop*	**sùùwè**	*to sell*	**báà**	*hut*
kùmnì-kpìnnĕ	*mother tongue*	**kùmù**	*to born*	**kpínné**	*language*

[4] **-si** is a kind of verbal extension among some other extensors (**-si**, **-tu** and **-po**) found in the language. Their structure and function are beyond the scope of the present study.

Compound noun	*Gloss*	Verb FUT	*Gloss*	Noun	*Gloss*
sàànì-bàá	*hut for sleeping*	**sɜ̀̀**	*to dwell*	**báà**	*hut*
tɛ̄ń-pùá	*habit*	**tɛ̄ńné**	*to get used to*	**púà**	*thing*

Some words make use of **reduplication**. Reduplication may concern one or two syllables (see (24)). The reduplication is total; the basic pattern is that if the stem is disyllabic, both syllables are reduplicated, whereas only one syllable is reduplicated in monosyllabic words. In some words, the first syllable becomes nasalized, but it is otherwise identical with the second syllable. The last syllable in the examples is the noun class suffix, which is not reduplicated. In many reduplicative words, it is not possible to state the meaning of the base alone, i.e. the stem that is repeated.

(24)

bɜ̀̀-bɜ̀̀-kúá	*hailstone*	**fùkó-fùkó-nú**	*lung*	**kpɜ̄̄-kpā-nă**	*harmattan-wind*
fī-fī-nú	*insect sp*	**kùló-kùló-nú**	*turkey*	**kpɛ́n-kpɛ́-nă**	*necklace*

3.4 Verbal morphology

In Samue verbs, the domains of tense, aspect, and mood are partially marked in the syntax (see verb phrases and verbal particles below 3.5) and partly in verbal morphology. In this section the morphology of verbs in Samue is discussed. Firstly, the verb classes are introduced. Secondly, a discussion about tense, aspect, and mood follows.

The **simplest (unmarked) verb form** is the form of the imperative mood (IMP), as Prost (1968) also mentions. In the present study, the simplest form is considered having the underlying tone from which the tonal behavior of the verb can be explained (see 7.3 for tonal analysis of verbs). The IMP and the perfective (PFV) have the same tonal and segmental structures, and for that reason in the examples IMP and PFV are glossed together. The only segmental difference is found in 23 monosyllabic CV-verbs, which are CV in imperative and are CVV in perfective.

3.4.1 Verb classes

The verbs in Samue can be classified in three different classes. The classification is based on the segmental inflection of the imperfective (IPFV) on the basis of the simple verb form. The verb classes show specific tonal alternations in the imperfective (IPFV) and in the future (FUT); their

tonal behavior is discussed in 7.3.2. Prost (1968:27) called IPFV the present tense, and he considered it to be a "lengthened" form of the perfective without giving any detailed classification.

There is no suffix that would clearly mark the IPFV (and future) in Samue, but vowel lengthening, suffixation, and tone change can all coexist, as studies in other Gur languages have revealed (Naden 1989). Thus the inflection of IPFV is quite complex. In this study, verbs are classified in three classes, which form arbitrary lexical sets that cannot be determined by phonological forms. The following classes are employed in order to explain the formation of imperfective:

- 1) vowel lengthening
- 2) vowel addition
- 3) syllable addition

3.4.1.1 Vowel lengthening

To make an IPFV form from PFV (see examples in (25)), the final vowel may be lengthened. The lengthened vowel is often /a/, but also /e/, /ɛ/ and /u/ are attested in final positions. Vowel lengthening concerns all verb structures, i.e. mono-, di- and trisyllabic verbs.

(25)

Monosyllabic			
Tone	**IMP/PFV**	**IPFV**	*Gloss*
Low	**kà**	**kā-ā**	*to crunch*
Mid	**nā**	**nā-ā**	*to give*
High	**cá**	**cā-ā**	*to offend*
Disyllabic			
Tone	**IMP/PFV**	**IPFV**	*Gloss*
Low	**fù̀kù**	**fū̃kūū**	*to turn*
Mid	**bēlē**	**bēlē-ē**	*to repair*
High	**sáká**	**sākāā**	*to wash*
High	**jááká**	**jāākā-ā**	*to cry*
Trisyllabic			
Tone	**IMP/PFV**	**IPFV**	*Gloss*
Low	**làkàsà**	**lākāsā-ā**	*to stick, to glue*
High	**múnúkú**	**mūnūkū-ū**	*to blow one's nose*

3.4.1.2 Vowel addition to vowel final stems

The vowel addition to vowel final stems concerns only monosyllabic verbs (see examples in (26)). Di- and trisyllabic verbs with a final vowel belong to the verb class 1) **vowel lengthening**. The vowel added to the verb stem may be /a/, /o/ and /e/. However, the stem vowel is not /a/ in this case. The vowel /o/ is added to stems ending in /u/, and /e/ to stems ending in /i/, according to vowel harmony (see more details in 6.4.2). The vowel /a/ attaches to stems ending both in /i/ or /u/; it is thus a lexically specified issue and not related to the vowel harmony. The monosyllabic verbs with a long vowel in IMP/PFV have a short stem vowel in IPFV.

(26) Imperfective inflection by vowel addition

Tone	**IMP/PFV**	**IPFV**	*Gloss*
Monosyllabic CV:			
Low	**nì**	**nī-āā**	*to drink*
Low	**pù**	**pū-ōō**	*to bury*
Mid	**bū**	**bū-āā**	*to remove*
High	**lí**	**lī-ēē**	*to kill*
Monosyllabic CVV:			
Low	**fùù**	**fū-āā**	*to meet*
High	**fíí**	**fī-ēē**	*to find*

Some verb stems undergo vowel modifications. This is rare and occurs only with monosyllabic verbs. Some monosyllabic verbs also have irregular forms concerning the vowel changes. Some examples of both cases are given in (27) below.

(27)

Vowel change	**IMP/PFV**	**IPFV**	*Gloss*
ɛ-ia	**bɛ́**	**bīāā**	*to hatch*
ɔ-ua	**tɔ-ni**	**tūāā-ni**	*to sit down*
Irregular verbs	**IMP/PFV**	**IPFV**	*Gloss*
	cìì	**cāā**	*to walk*
	pā	**pēē**	*to come*

3.4.1.3 Vowel addition to consonant final stems

Only di- and trisyllabic verbs have consonant final stems. The tone is the same in all syllables. The added final vowel in IMP/PFV is the same as the stem vowel, except for the stem vowel /a/,

which acquires an added vowel /i/ (see examples in (28)). The added vowel in IPFV is the majority of cases /a/. However, it may also be /o/ after stem vowel /u/, or /e/ after stem vowel /i/, conditioned by vowel harmony (see more details in 6.4.2). Rare cases with /n/-final stems belong to the verb class three (see 3.4.1.4).

(28)

	Disyllabic				
Change	Tone	Stem	**IMP/PFV**	**IPFV**	*Gloss*
i-e	High	jííb-	**jííb-í**	**jīīb-ēē**	*to fill*
i-a	Mid	bām-	**bām-ī**	**bām-āā**	*to sew*
ɛ-a	Low	pɛ̀ɛ̀k-	**pɛ̀ɛ̀k-ɛ̀**	**pɛ̄ɛ̄k-āā**	*to watch*
u-a	High	wű́k-	**wű́k-ú**	**wū̃k-āā**	*to defecate*
u-o	Mid	būl-	**būl-ū**	**būl-ōō**	*to harvest peanuts*
ɔ-a	Low	bɔ̀ɔ̀k-	**bɔ̀ɔ̀k-ɔ̀**	**bɔ̄ɔ̄k-āā**	*to worry*
	Trisyllabic				
ɛ-a	Low	tɛ̀ɾɛ̀k-	**tɛ̀ɾɛ̀k-ɛ̀**	**tɛ̄ɾɛ̄k-āā**	*to apply*
i-e	High	jíɾík-	**jíɾík-í**	**jīɾīk-ēē**	*to tremble*

3.4.1.4 Syllable addition

IPFV-inflection may also be performed by a suffix which is a whole syllable added to the verb stem. The suffix onset consonant /n/ or /s/ is followed by a long vowel /ee/ creating a **nnee** or **see** syllable. The fricative /s/ is not frequent in this position; only 12 verbs with **see** are found among a total of 370 verbs. On the other hand, the addition of **nnee** syllable is frequent in about 100 verbs. Addition of **nnee** creates a geminate nasal, even if the stem does end in an oral vowel as in (29) and (30) (see more on long consonants in section 6.1.7). Some stems have a /n/-final stem, such as **mán-í** (IMP, *to talk*) vs. **mān-nnēē** (IPFV), which results as [mannee].

(29) IMP [púó] → IPFV [pūōnnēē] *to harvest*
(30) IMP [táágá] → IPFV [tāāgānnēē] *to approach*

The monosyllabic verbs with the **nnee** addition have a low or high tone (see (31)). The monosyllabic verbs with **see** on the other hand have a long vowel in IPFV. In eight monosyllabic verbs, the syllable addition is done by a rare **jee** syllable; all of them have a high tone stem also in IPFV (see the category b) below for the disyllabic verbs). There are also two irregular cases: the verb **céé** (PFV, *to watch*) which has the IPFV with **kēē** (**cēē-kēē**), and the verb **sū** (PFV, *to sell*) with **wee** (**sūū-wēē**). All the disyllabic **see** verbs have a low tone (see (31)).

(31)

Tone	IMP/PFV	IPFV	*Gloss*
Monosyllabic -nnee			
Low	**fìà**	**fiā̃n-nēē**	*to remove embers*
High	**kpá**	**kpān-nēē**	*to dry*
Monosyllabic -see			
Low	**kà̀**	**kā̃ā̃-sēē**	*to scratch*
Mid	**nā**	**nāā-sēē**	*to miss*
High	**cíí**	**cīī-sēē**	*to insult*
Monosyllabic -jee			
High	**já**	**jáá-jēē**	*to ask*
High	**wáá**	**wáá-jēē**	*to plough the rice field*
Disyllabic -see			
Low	**tù̇̃mù**	**tū̃mū-sēē**	*to cultivate*

The disyllabic **nnee**-verbs have low or high tone, the trisyllabics have a high tone. High tone verbs are divided into two different groups according to their tonal behavior (see (32) below). This behavior is further discussed in chapter 7.3.2.

- **category a)** has a mid tone in IPFV and low tone in FUT.
- **category b)** has a high verb stem in all the inflected forms. The mid tone of IPFV is realized on the last added syllable of the IFPV form. About twenty verbs have this pattern.

(32)

	Tone	**IMP/PFV**	**IPFV Mid**	**FUT Low**	***Gloss***
Category 1)	Low	jìlè	**jīlē-nnēē**	**jìlè-nnè**	*to enter*
	High	wű́kó	**wū̃kō-nnēē**	**wù̀kò-nnè**	*to become satisfied*
	High	júɾúmá	**jūɾūmā-nnēē**	**jùɾùmà-nnè**	*to drizzle*
Category 2)		**IMP H**	**IPFV H-M**	**FUT High**	
	High	tóókó	**tóókó-nnēē**	**tóókó-nné**	*to send*
	High	cólő́kó	**cő́lónkó-nnēē**	**cólónkó-nné**	*to be healthy*

3.4.2 Tense, aspect and mood

Verbal categories that are marked in the morphology, i.e. by inflection, are discussed in this section. The verbal syntax expressed by separate particles will be examined in section 3.5 in the verb phrase. Tense and mood are partially marked by morphology in Samue, while aspect is

solely expressed in the morphology of the verb. In what follows, aspect is discussed first, because in Samue, as in other Gur languages (Naden 1989, Bendor-Samuel 1971), the main distinction in the verb system is between the perfective and imperfective aspect. Secondly, future tense expressed by inflection is discussed, followed by a description of the imperative moods.

3.4.2.1 Perfective aspect

The perfective aspect refers to an action already accomplished; it could also be called completive. The perfective aspect may have a temporal value of the past tense; the process is finished, but its effect may not be long-lasting, as in (33) and (34). Inchoative or stative verbs are normally used in perfective; the effect of the complete process is still important (35).

(33) Ì **pā** nā.
3s come(PFV) AFF
He has come. (it is possible that he is still there, or that he is already gone.)

(34) Pì wɔ̀n-í nā í pì kpís-í.
3p eat-PFV AFF CON 3p finish-PFV
They have already eaten.

(35) Númú ǹ **jìì** nā.
water pNH be.dirty(PFV) AFF
Water is/has become dirty.

In most cases, the simplest verb form the imperative is also the perfective form. Only 23 monosyllabic verbs are found, where imperative structure is CV, but the perfective is CVV (see (36)). The perfective aspect tone is always the same as the underlying tone of the verb.

(36)

IMP	PFV	*Gloss*
fè	fèè	*to greet*
kpá	kpáá	*to open*

3.4.2.2 Imperfective aspect

The imperfective aspect indicates an action that is ongoing or continuous. If the temporal reference of the context is present, imperfective refers to a process that is occurring at the time

of the enunciation (37), i.e. it is progressive. It refers also to generic truths (38), or expresses the habitual in some contexts (39). The imperfective aspect is expressed by inflection, as shown above with verb classes (see 3.4.1) and by a mid tone on the verb stem or on the IPFV-suffix. Tonal behavior of IPFV is discussed in section 7.3 focusing on the tone.

(37)

Kūmbā	mì	ū	jā̄mā-ā?	– Ńtì	jáā́sé	ń	kā̄-jēē	nā.
what	2s	sNH	do-IPFV?	1s	sauce	pNH	stir-IPFV	AFF

What are you doing? – I stir (am stirring) the sauce.

(38)

Cáá	nkí	nū,	sɔ́ká	kì	wūnsōn-nēē	nā.
rainy.season	in	SUB	herb	sNH	grow-IPFV	AFF

During the rainy season, the grass grows.

(39)

Kúá	ò	kúá	bākùù-má	pì	bāā-má	ń	kū-ā̄ā̄	nā.
day	ITER	day	shepherd-pl	3p	sheep-pl	pNH	tend-IPFV/HAB	AFF

Every day, shepherds tend the sheep.

3.4.2.3 Future tense

The future tense indicates an event that is not yet carried out, but it would be accomplished in the future (temporal value). At the moment of speech the process is thus hypothetical (40). The future tense form is also used in optative mode (see section 3.4.2.4) to express a wish, which is also part of the hypothetical truth.

(40)

Ì-ì	kpà	bɛ̀?	- Ì-ì	kpà	nā.
3s-FUT	die(FUT)	NEG.Q	3s-FUT	die(FUT)	AFF

He will die, won't he? – He will die.

The future tense inflectional suffix is the same as for IPFV, except for the fact that in IPFV, the final vowel is long, in FUT it is short (see (41)). Future tense has a low tone, except for the category b) of the 3)-class verbs, where IPFV and FUT are formed with a syllable addition. Tonal alternations of the future tense will be discussed in 7.3.2.

(41) Future tense inflection

Tone	IMP/PFV	IPFV	FUT	*Gloss*
Low	**kà**	**kā-ā**	**kà**	*to crunch*
High	**cá**	**cā-ā**	**cà**	*to offend*
Low	**nì**	**nī-āā**	**nì-à**	*to drink*
Mid	**pū**	**pū-ōō**	**pù-ò**	*to bury*
High	**lí**	**lī-ēē**	**lì-è**	*to kill*
Low	**kǎ̀**	**kǎ̄ǎ̄-sēē**	**kǎ̀ǎ̀-sè**	*to scratch*
Mid	**nā**	**nāā-sēē**	**nàà-sè**	*to miss*
High	**kpá**	**kpān-nēē**	**kpàn-nè**	*to dry*

The Future is also marked by the lengthening of the last vowel of the subject pronoun, see (40). The last vowel is **i** for all other persons except for the second person of the plural, which is **a**. This vowel lengthening could be considered as a future particle formed by a vowel, which is assimilated into the preceding vowel quality. However, this option is not studied in more detail in the present study.

3.4.2.4 Imperative moods

The imperative as a verbal form is the simplest in Samue, as Prost (1968) also mentions. The imperative mood is used to give direct commands, and it is grammatically attested only in the second person plural (42) and singular (43).

(42) Á pā náánì!
2p come(IMP) here
Come here!

(43) Mì násí bɔ̀!
2s to.be.afraid(IMP) NEG
Don't be afraid!

Commands are more often given in more polite form than the imperative. In this study, this indirect imperative is called **jussive**. Jussive is an imperative mood often addressed to a third person (Aikhenvald 2010); first and third person indirect commands occur also in Kabiye (a Gur language spoken in Togo), referred to as jussive by Rose (2010). In Samue, the imperative is considered to be too direct, and thus impolite when addressed to equals or elders. The jussive could be literally translated "*that you x*" (cf. Cahill 2007a:403 for the same kind of imperative in Kɔnni (Gur, Ghana), although Cahill labels it as a possible hortative mood, not as a jussive).

Prost (1968) talked about the subjunctive in Samue, but he gave examples only in complex phrases where the main clause has a verb '*to say*'. It is thus difficult to conclude whether his subjunctive is the same mood as what is called the jussive in the present study.

The jussive is attested in all persons. Its verbal form is the same as that of the imperative, but it is always preceded by a conjunction **á**, with a high tone, and by a pronoun with a high tone (see (44)). The jussive in Kabiye (Rose 2010) and in Sissala (Neukom p.c.), a Gur language spoken in Burkina Faso, is also expressed by a high tone which precedes the base of the verb, i.e. the high tone is realized on the subject pronoun or on an epenthetic vowel.

(44) Examples of jussive with the verb **céé**, *to look at*.

Person	**JUS**	*Gloss*
1s	**Á ń céé!**	*That I look at!*
2s	**Á mí céé!**	*That you look at!*
3s	**Á í céé!**	*That he looks at!*
1p	**Á tí céé!**	*That we look at!*
2p	**Á á céé!**	*That you look at!*
3p	**Á pí céé!**	*That they look at!*

The optative mood expresses a wish, and not a command. Its verbal form is the future. It is preceded by a conjunction **á**, with a high tone, and by a pronoun with a mid tone (see (45)). It is attested in all persons.

(45) Examples of optative with the verb **céé**, *to look at*.

Person	**OPT**	***Gloss***
1s	Á n̄ cèèkè!	*May I look at!*
2s	Á mī cèèkè!	*May you look at!*
3s	Á ī cèèkè!	*May he look at!*
1p	Á tī cèèkè!	*May we look at!*
2p	Á ā cèèkè	*May you look at!*
3p	Á pī cèèkè!	*May they look at!*

3.5 Verb phrase and verbal particles

Verbal particles in Samue contain information mainly concerning tense, as aspect and mood are expressed in the morphology of the verb. Additionally, negation and affirmation are expressed by particles.

3.5.1 Tense particles

There are three tense particles in Samue: **ntē**, **lɔ̄** and **ntā** (46).

(46)
nte remote past
lɔ̄ recent past
ntā habitual

The past tense particle **ntē** refers to events which occured previously in time. **Ntē** is normally used to express events which have occurred in the remote past. On the other hand, the particle **lɔ̄** is always used in reference to the recent or immediate past, referring to the same day as in (47). Both particles are used with imperfective and perfective aspects. When a perfective verb is combined with **ntē**, the event is accomplished in the past; in that case **ntē** follows the verb (48). When **ntē** is combined with an imperfective verb, **ntē** is placed in front of the verb (49), and the reference is to a habitual or continuous event in the past. Particle **lɔ̄** can be combined in the same manner when referring to events on the same day.

(47)	ńtì	**lɔ̄**	wē	sāānī	nā.
	1s	PST.REC	there	this.morning	AFF
	I was there this morning.				

(48)	Tí	súјé	**jìn-ì**	**ntē**	bóókò	wúnā	jīī	nā.
	1p	parents	leave-PFV	PST	village	INDEF.sNH	EXT	AFF
	Our parents had left the village.							

(49)	Tí	tōnú	nkáá	**ntē**	ú	**má-jē**	tíntíá.
	1p	all	PRES.sNH	PST	sNH.OD	build-IFPV	before
	It was all of us who were building (built) before.						

The habitual future is rarely attested in the corpus. The few examples show that **ntā** has the same habitual value as **ntē**, when the latter is used with a verb in the imperfective aspect in order to express habitual events in the past (50). However, **ntā** is used with a verb in the future tense.

(50) Á pí lí kpìfiā̄-nī bɔ̀, á ńkáà **ntā** pí náá **wìà.**
that 3p kill(JUS) rooster-DEM NEG that PRES.sNH HAB 3p.PSS mouth look.for
That they do not kill the rooster, that it's it that will look for their food [lit. their mouth] (habitually). [from a fairytale where the rooster went to pick up seeds and brought them back to home hidden in his wings.]

3.5.2 Negation and affirmation

The negative particle **bɔ̀** is always in a sentence final position (51). The affirmative particle **nā** is also normally placed in the final position (52); it is an obligatory particle at the end of every basic affirmative sentence. Only some adverbs, modifying the verbal phrase, are attested after **nā**. The affirmation particle is widely used in Gur languages, although sometimes the sentence final particle marks aspect rather than affirmation (Bendor-Samuel 1971). Negation is typically marked by pre-verbal morphemes in Gur languages, but it may be accompanied by sentence final negation marking (Winkelmann & Miehe 2009). Winkelmann and Miehe (2009) discuss the fact that in a few Gur languages only the sentences final particle marks the negation; the authors consider this as a remarkable feature. Prost (1968) mentions both **bɔ̀** and **nā** particles, although in the Néguéni dialect the affirmative particle is pronounced [**ni**]. Typologically, the situation is untypical, as the affirmative is often less marked in comparison to negation (Croft 2003).

(51) ì pēē **bɔ̀.**
3s come(IPFV) NEG
He does not come.

(52) ì pēē **nā.**
3s come(IPFV) AFF
He comes.

3.6 Pronouns

The class of pronouns includes personal, indefinite, relative and interrogative pronouns. Only personal pronouns are examined in this brief discussion on the pronominal system. This choice

is due to the importance of personal pronouns to the verb phrase and its tonal behavior (see section 7.4). The different forms of personal pronouns are listed in Table 1 below. The first part introduces the pronouns of the 1st and 2nd person, which Naden (1986) refers to as speaker/hearer pronouns when speaking about the Western subgroup of Oti-Volta Gur-languages. Pronouns, which refer to the third persons, have both human and non-human forms in Samue. Both subject and direct object third person pronouns in IPFV are used in conjunction with the nominal subject and nominal direct object (see section 3.1). Prost's (1968) list of pronouns is mainly the same, except for the plural forms of direct object PFV pronouns, which he considered to be the same as the indirect object forms.

Table 1. Table of personal pronouns.

	Emphatic pronoun	**Subject pronoun PFV/IPFV**	**Direct object IPFV**	**Direct object PFV**	**Indirect object**	**Possessive**
1s	béé	ńtì/ń	n	be	bé	ǹ
2s	máá	mì	mi	mi	májɛ̄ɛ̄	mí
1p	tímíjéé	tì	tí	tímí	tímíjɛ̄ɛ̄	tí
2p	ámíjéé	à	á	ámí	ámíjɛ̄ɛ̄	á
	Human					
3s	ísé	ì	i	u	ísɛ̄ɛ̄	í
3p	péé	pì	pí	pɛ́ɛ́	péé	pí
	Non-human					
sg	ńkíní, ńkáá	kì/ù	u	ú	kɛ̄ɛ̄	ú
pl	ńpɛ́ɛ́	ǹtì/ǔ	ũ	ní	nɛ̄ɛ̄	ű

Subject pronouns and direct object pronouns in IPFV are segmentally the same, except for the first person singular, which has two different forms, one for IPFV (**ńtì**) and another one for PFV (**ń**). Singular direct object pronouns in IPFV and in PFV are tonally influenced by the verb (see section 7.4 for details), whereas the plural direct object pronouns are always high. In IPFV and in the future tense, the direct object pronoun is placed in front of the verb, while in PFV it follows the verb. Indirect object pronouns always follow the verb.

The subject pronouns are also used as pronominal possessives, but possessives have opposite tones in comparison to subject pronouns. Emphatic pronouns are attested alone, i.e. not adjacent to a verb. Non-human singular direct object pronouns are influenced by the tone of the verb in IPFV. Non-human subject pronouns have different forms for IPFV and PFV aspects.

3.7 Synthesis of the morphology with typological remarks

In this chapter, the main features of the morphology of Samue are examined. In the present section, the characteristics of Samue are discussed in relation to the morphological phenomena in Gur languages. The discussion begins, however, with a syntactic property.

Naden (1989) notes that the published syntactical studies of Gur languages are scarce. In this brief overview of Samue grammar, the concentration was on the morphology of Samue and not on the syntax. The only clearly syntactic phenomenon mentioned was the word order, which changes in Samue according to the aspect of the verb. In the perfective, the word order is subject-verb-object, whereas it is subject-object-verb in the imperfective aspect. Prost (1968) already considered this as a particularity of Samue. It is reported, that the word order in Gur languages is typically subject-verb-object (Williamson & Bench 2000). However, different verbal elements, e.g. tense or negation, change the word order in the Gurunsi-subgroup of Gur languages (e.g. Winkelmann & Miehe 2009). Typologically, both word orders are frequent in the languages of the world (e.g. Tomlin 1986).

With regards to the **noun morphology** of Samue, most of the structures found in Samue are also attested in Gur languages in general, but not necessarily in all Gur languages. In Samue, the stem vowels alter sometimes between singular and plural; this vowel modification is attested also in other Gur languages, for example in Mampruli (Osbiston & Naden 1980). The nominal morphology is characterized by noun classes in Gur, as in many branches of the Niger-Congo family (e.g. Williamson 1989). Noun classes in Gur are usually expressed by singular and plural suffixes, and only rarely by prefixes (Naden 1989). In Samue, as shown previously, only suffixes are attested in noun classes.

According to Winkelmann (2007b), the plural suffixes of Samue conform to the reconstructed Proto Gur plural suffixes, but some singular suffixes are unique for Samue (such as single classes **-na** and **-nu**). The Samu-Group, which includes Samue, Palɛni and Natioro (see section 2.1) lacks the singular class **-dɪ** found in nearly all Central Gur languages (ibid.). The class system of the three languages in Samu group is reduced, because the pairings between singular and plural suffixes are not clear anymore (Winkelmann 2007b), as was shown with the Samue examples (section 3.1). The pronouns attested in Samue correspond to those of Proto Gur (Winkelmann

2007a), but the concord system is reduced, as the distinction is only between human versus non-human. This is the case in the whole Samu group (Winkelmann 2007b). In some Gur languages, however, the pronominal concord system has specific concords for several classes and there are also languages where the pairings between singular and plural are still very clear, but most of the Gur languages have a reduced noun class system (Miehe et al. 2007).

The associative noun phrase order in Samue is typical in Gur; the dependent noun precedes the head noun (Naden 1989). According to Naden (1989), only the definite article is marked in Gur languages. As shown previously, Samue employs the so-called reminder pronoun that always follows the subject noun. In the light of other Gur languages, the reminder pronoun in Samue could be analyzed as the noun phrase's final definite marking, although its form is the same as for personal pronouns. Several types of compounds are attested in Samue. In addition, reduplication is attested in the word formation of Samue; this is typical cross-linguistically (e.g. Dimmendaal 2000).

In Gur languages, the **verb is often inflected for aspect**. Different forms are found for the imperfective and neutral, and a little less frequently a third form for the perfective, as well as an imperative mood (Naden 1989). If the imperfective aspect is not marked by a clear suffix, several markings may coexist, such as tone change, vowel lengthening, and suffixation (ibid.). In Samue, these Gur verb morphological characteristics are also attested. The grouping of the verbs according to different imperfective marking is arbitrary in Samue, as in some other Gur languages (Naden 1989). In Samue, three verb classes are found: vowel lengthening, vowel addition, and syllable addition. The lexical tone of the verb is neutralized in the imperfective aspect and in the future tense (see more on tone in chapter 7.3). Exceptionally, the future tense in Samue is also marked by inflection, whereas in many Gur languages tense and irrealis are marked by verbal particles (ibid.).

In Samue, orders are often expressed in a more polite manner than the imperative. This same pattern is also found in some other Gur languages, where the jussive is used instead of the imperative (Naden 1989). In other Niger-Congo languages, for example in some Bantu languages, the same type of polite imperative is expressed by the subjunctive. The subjunctive is also labeled the optative or injunctive in Bantu languages (Nurse 2010).

Many verbal particles or tonal morphemes are used in Gur languages, for example to express tenses (Naden 1989). According to Naden (ibid.), verbal particles tend to be preverbal. In Samue, there are three tense particles, which are attested in front of the verb or following it. The past tense particle precedes the verb in the imperfective aspect, but it follows the verb in the perfective aspect. The reference to the event is different in both cases: continuous in the past with an imperfective verb, and accomplished in the past with a perfective verb.

Negation is typically marked preverbally in Gur languages, but the negation marking is sometimes repeated finally in the sentence (e.g. Naden 1989, Winkelmann & Miehe 2009). In Samue, however, the negation particle is always in the final position in the sentence (see 3.5.2), as is the case in a few other Gur languages (Winkelmann & Miehe 2009). The negation particle replaces the affirmative particle in Samue, thus reversing the truth value of the sentence in question. In other words, the negation and the affirmation are both marked in Samue, as the affirmative particle is an obligatory sentence constituent in basic sentence (see section 3.5.2). This is typologically rare, as typically negation is more marked than affirmation (e.g. Croft 2003).

To summarize, it is possible to state that Samue has all the typical morphological features that Gur languages in general tend to have. The only deviant properties are the change in word order depending on the aspect, and the marking of both affirmative and negative by a separate particle. The latter phenomenon, however, also exists in some other Gur languages (Winkelmann & Miehe 2009).

4 SEGMENTAL AND TONAL PHONOLOGY

Without considering any theoretical issues at this point, the most common phonological characteristics of the Niger-Congo languages are discussed in this chapter in general, with particular attention on Gur languages. Tone is discussed separately in section 4.2 including a more detailed introduction to tonal processes before discussing the characteristics of tone in the African continent. Special attention is directed to what is known about tone in Gur languages to date. The chapter ends with an examination of some fundamental differences between tonal and segmental phonology.

4.1 Phonology

Phonology deals primarily with contrastive speech sounds and their behavior in a system, i.e. in a particular language. Goldsmith (1995) formulates the general issues that phonological theories also intend to explain in the following manner; 1) generally, segmental phonological studies of a language include the **phoneme inventories** of contrastive phones (i.e. phonemes), 2) the **phonotactic principles** of how to form a phonological word, and 3) **alternations** that modify phonological or morphological units in different contexts. Beside this, there are different prosodic and suprasegmental properties, e.g. length, stress, accent and tone, are examined.

The basic concept in phonology is **well-formedness**; that is what the allowed combinations of segments are, and what restrictions are set to model the *phonotactics* of a language (Goldsmith 1995). The well-formed words consist of *phonemes*, the smallest distinctive units in a sound system (e.g. Bloomfield 1933/1973, Trubetzkoy 1958/1969, Jones 1967). Phonemes may have *allophones*, different phonetic realizations of phonemes, which are conditioned by distinctive phonetic contexts (e.g. Jones 1967). Moreover, morphophonological changes are attested, when phonetic contexts alter the phonemes' realizations, e.g. by assimilation or by other phonological processes (e.g. Trubetzkoy 1958/1969, Jones 1967).

In this chapter, segmental and tonal phonologies are discussed in relation to the Niger-Congo languages. As mentioned earlier, many Gur languages still lack detailed phonological and tonal analyses. The characteristics given in this chapter are based on the data available. Nevertheless, Naden (1989:151) mentions that the unity of Gur languages as a group is questionable, and for

that reason it is "impossible to make generalizations about Gur". He listed features found in many Gur languages in his report (id.). The characteristics mentioned by Naden (1989) and others (e.g. Clements & Rialland 2007, Manessy 1979, Bendor-Samuel 1971), and descriptions of individual languages, such as Kɔnni (Cahill 2007a), Koromfe (Rennison 1997), Mbèlimè (Neukom 2004), include sketches of possible phoneme inventories, specific features that are frequent in this geographic area, syllable types and some phonological processes, such as vowel harmony whose effect may cover the whole word, and the assimilation of the place of articulation, which influences only the adjacent sounds in an utterance.

Clements and Rialland (2007) divide the African continent into six major zones by phonological properties that more commonly occur within a particular zone than outside it[5]. The **Sudanic belt zone** includes all the non-Bantu Niger-Congo languages (thus including Gur), some Bantu languages, the Chadic subgroup of the Afroasiatic language phylum and also most of the Nilo-Saharan languages. In what follows, Sudanic belt zone characteristics are discussed particularly as regards the Gur language features, whilst also referring to other resources.

4.1.1 Consonants

Some **consonantal features** are especially common in the Sudanic belt zone. Three features typically found in the Sudanic belt are: labial flaps, labial-velars and implosives (Clements & Rialland 2007:40). **Labial flaps** are not found across the zone; they are lacking in West-African languages (Olson & Hajek 2003). However, **labial-velars** occur across the Sudanic belt. The most common labial-velars are the occlusives /kp/ and /gb/. In the Sudanic belt, the **implosives** are best defined as nonobstruent stops (Clements & Rialland 2007). According to Manessy (1979), there are no implosives in central Gur languages, but they may occur in some western Gur languages (Naden 1989). This is reported at least by Sissala (Neukom 2014) and Dyan (Palm 2001), both spoken in Burkina Faso. In general, **voiced stops** are attested in languages of the Sudanic belt. According to Clements and Rialland's database (2007), among the Sudanic belt, only some Bantu languages lack voiced stops. In some African languages, the **voiceless labial stop** fails to occur as a phoneme, but this is not very common in the Sudanic belt. Lack of /p/ is, however, is reported, at least in one Gur language, namely Tem spoken in Togo (Tchagbale

[5] Clements & Rialland (2007) have based their survey on a modified UPSID (The UCLA Phonological Segment Inventory Database, http://web.phonetik.uni-frankfurt.de/upsid_info.html) database including a total number of 151 African languages. Among 88 Niger-Congo languages, altogether 22 Gur languages are mentioned for different phonological phenomena.

1984). Prenasalized consonants or nasal plus stop clusters are typical in Niger-Congo languages (Williamson 1989).

A typologically unusual phenomenon is the lack of **contrastive nasal consonants** in some languages of the Sudanic belt, including some Gur languages, e.g. Buamu and Senadi/Senoufo (Clements & Rialland 2007) and Naténi (Nédellec & Bukies 2008). An example is provided in (53) illustrating the allophonic relation between obstruents and nasals in initial position in oral vs. nasal vowel environments in Naténi. In these languages oral and nasal vowels contrast, but nasal consonants are conditioned by the nasal environment, and they are often in allophonic relation with non-obstruent consonants. However, this phenomenon is not widely reported in Gur. In the Gur family, nasal consonant phonemes often assimilate to the same point of articulation as the following consonant, and oral consonants may also assimilate to nasal quality (Naden 1989:157), the latter phenomenon being less frequent in the languages of the world than place assimilation. According to Naden (1989:153), phonemic nasal consonants are often restricted from two to three in Gur.

(53) Naténi (Gur, Bénin[6]) from Nédellec and Bukies (2008:10-11)

/b/ → [m] before Ṽ	*Gloss*	/d/ → [n] before Ṽ	*Gloss*
/**b**ɛ̃Ntá/ → [**m**ɛ̃Ndá]	*to drive*	/**d**ɔ̃dí/ → [**n**ɔ̃rí]	*to increase volume*
/bɛ́Ntá/ → [bɛ́ndá]	*to broke a fragile thing*	/dɔ̄dī/ → [dɔ̄rī]	*to fall*

The Gur language consonant system (see Table 2) can be as described by Bendor-Samuel (1971). His system is simpler than that proposed by Manessy (1979), because it lacks implosives, which are added to Table 2 according to Manessy (1979). The Gur consonant phonology typically includes five points of articulation: labial, alveolar, palatal, velar and labial-velar (Naden 1989:152). It has voiced and voiceless stops and fricatives, plus /l/, /j/ and /w/. Naden states (id.) that [r] is usually a non-initial allophone of /d/, and that /g/ is often weak having allophones such as [ʔ], [ɣ], [j], [w] or zero. Naden (1989:152) also mentions that velar and labial-velar obstruent sets are partially complementary, i.e. there are restrictions as regards which vowels the labial-velar can be combined. Cahill (1999:159) observes that cross-linguistically round back vowels that are high or mid are often missing after a labial-velar stop.

[6] In the examples, the language family is given in brackets, followed by the country in which the language is spoken.

Table 2. Sketch of Gur consonants, modified from Bendor-Samuel (1971).

	labial	**alveolar**	**palatal**	**velar**	**labial-velar**	**glottal**
stops	p	t	c	k	kp	
	b	d	ɟ	g	gb	
nasals	m	n	ɲ	ŋ	ŋm	
implosives	ɓ	ɗ	ʄ			
fricatives	f	s				h
	v	z				
liquids		l, r				
semivowels			j	w		

4.1.2 Vowels

Vowel systems in the Niger-Congo languages vary from 5-vowel systems to 10-vowel systems. Gur languages also contrast between 5 and 10 oral vowels (Bendor-Samuel 1971), although according to Naden (1989), the generalizations about vowel systems are elusive. **Nasal vowels**, in general, are common in Niger-Congo, especially among Mande, Kwa, Gur and Adamawa-Ubangi subgroups (Clements & Rialland 2007). In relation to the Gur family, nasal vowels are found especially in southwestern Gur languages and in Gurma languages (Naden 1989:154).

Vowel length is systematically contrastive in Gur languages, but sometimes the vowel length is conditioned by a morphophonemic alternation (Naden 1989: 154). As Bendor-Samuel (1971) mentions, a common feature in Gur is a variable length of noun stems between singular and plural forms. An example of this is from Dagaare (Ghana), where the stem vowel is lengthened in the plural form in particular noun classes, as illustrated in (54) (Bodomo & Marfo (2006:211, 222, 226). Additionally, **vocalic alternations** between singular and plural are reported in some Gur languages, e.g. in Mampruli with words like **yoofu-yuri**, *horse*, and **waafu-wiigi**, *snake* (Osbiston & Naden 1980).

(54) Stem vowel lengthening in Dagaare (from Bodomo and Marfo 2006:210-211).

stem	**sg**	**pl**	***Gloss***
kù-	kú-ó	kúú-rí	*rat*
tì-	tì-é	tìì-rì	*tree*
bì-	bí-é	bíí-rí	*child*

Diphthongs occur in Gur languages, but their origins differ, e.g. they may be realizations of long vowels, they may originate from metathesis of CV-suffixes, from spread of vowel quality

of a suffix or from weakening or loss of a medial consonant in CVCV structures (Naden 1989:154-155). According to Cahill (2007a), in Kɔnni (Ghana), phonological long mid vowels surface as phonetic diphthongs, as long mid vowels do not exist phonetically. This is illustrated in (55) below.

(55) Mid vowel diphthongization in Kɔnni (Cahill 2007a:226-227)

	Example	*Gloss*
[ie] comes from /ee/	**bítíéŋ**	*beard*
[ɪa] comes from /ɛɛ/	**líˈáŋ**	*axe*
[uo] comes from /oo/	**jùóŋ**	*room*
[ʊa] comes from /ɔɔ/	**dùáŋ**	*bush-big*

Vowel harmony means that all the vowels in some domain, typically the phonological word but also the stem only, assimilate according to a feature locally or non-locally (e.g. Rose & Walker 2011). Thus, vowels often share the same value of a common feature. All vowel qualities can trigger or cause harmony, but all vowels can also be targets, i.e. they undergo harmony (ibid.). In harmony systems, some segments are *blocking* as they halt harmony, and others are called *transparent*, i.e. they do not harmonize, but they do not prevent harmony of the subsequent vowels. As Rose & Walker (2011) mention, vowel harmonies include backness, round, height, tongue root and complete harmony. In what follows, some examples are given from Advanced Tongue Root (ATR) harmony and other existing harmonies in Niger-Congo and especially in Gur languages. The theoretical analysis of vowel harmonies is discussed in chapter 5.3.2.

As Casali (2008) summarizes, **Advanced Tongue Root** (ATR) harmony is not qualified well enough when based solely on the tongue root advancement, as it was first referred to, and other factors need to be considered as well. Lindau (1976) was one of the first to indicate that tongue root advancement was only one gesture influencing the increase or the decrease of the pharyngeal cavity that occurs with [ATR] vowels, since the tongue body height also changes the affect of the harmony feature [ATR], as Lindau and Ladefoged (1986) report for Dho-Luo (Nilotic, Kenya). However, the term [ATR] is widely used. The major acoustic correlate of the [ATR] feature is the first formant frequency, F1. F1 values are higher for [-ATR] vowels, than for [+ATR] vowels (e.g. Casali 2008).

The [+ATR] vowels are /i, u, e, o, a/, and [-ATR] vowel series includes /ɪ, ʊ, ɛ, ɔ, ə/ as presented in (56) (e.g. Casali 2008). The most common system, however, has only nine vowels, having /a/ as a neutral vowel, and lacking its [+ATR] counterpart /ə/ (e.g. Creissels 1989, Casali 2008:501-502). Vowels from opposite sets of [ATR] value do not normally co-occur in a root morpheme. In the common case, the affix will harmonize to the [ATR] quality of the root, although the opposite case is also possible, but rare.

(56)	+ATR		-ATR	
high	**i**	**u**	**ɪ**	**ʊ**
mid	**e**	**o**	**ɔ**	**ɛ**
low	**ə**		**a**	

[ATR] harmony is widely distributed in Niger-Congo and also Nilo-Saharan languages (Casali 2008). It is especially common in Gur, Kru, Kwa and some Benue-Congo subgroups. Languages with a 7-vowel systems (/i, e, u, o/ and /ɛ, ɔ, a/) are extremely common, especially in West and Central Africa; the 7-vowel system may also lack the mid [+ATR] vowels and has the following vowels: (/i, u/ and /ɪ, ʊ, ɛ, ɔ, a/) (Casali 2008:503). Casali (1995a) suggests that ATR-harmony may have been under reported in Gur in the past, as in some other Volta-Congo languages, sometimes because of the inadequate descriptions. Naden (1989) doubts the ancient origin of ATR-harmony in Gur, but in many Central Gur languages the harmony is attested (e.g. Dakubu 1997). A thorough description of vowel harmony systems in Gur is not available, but it seems that several vowel harmony systems co-exist with ATR-harmony (cf. Kaboré & Tchagbalé 1998).

An example of ATR harmony in Kassem (Gur, Burkina Faso & Ghana) is given below. Kassem has a symmetric ten-vowel ATR system with harmonizing affixes. The example (57) from Callow (1966:30)[7] shows a singular suffix of one noun class. The suffix is [a] or [ə] according to the ATR value of the root.

(57) ATR harmony example from Kassem

-ATR root		**+ATR root**	
dʒɪn-a	*hand, arm*	**dig-ə**	*room*
nag-a	*leg*	**ləŋ-ə**	*song*
zʊn-a	*calabash*	**bug-ə**	*river*
kɔg-a	*back*	**tʃoŋ-ə**	*path*

Other than [ATR] vowel harmony, there are other types that occur in the African continent. **Height vowel harmony** occurs especially in Bantu languages, which often lack ATR harmony (Clements & Rialland 2007). Labial or back harmony is attested in West African Niger-Congo languages, for example in the Kwa family (Williamson 2004). Bendor-Samuel (1971:154) mentions **high-low harmony** and **front-back harmony** for Sissala (Gur, Burkina Faso) in some contexts, although Sissala is reported to have a strong ATR-harmony (Neukom 2014). In addition, a Senoufo language, Supyire (Gur, Ivory Coast), is considered to have a multiple vowel harmony (Carlson 1994).

[7] Callow (1966) did not mark tone.

An example of back harmony is given below. In Kabiye (Gur, Togo) vowels harmonize according to ATR harmony, but there are prefixes that harmonize to the first vowel of the following root completely or partially with respect to [back] feature, as shown below in (58) (Padayodi 2008:219). When the prefix is harmonized only partially, it may be front or back, as in examples *his root* and *his shirt*.

(58) [back] feature harmony in Kabiye

bV̀-prefix (possessive), complete harmony		V̀-prefix (possessive), partially taking [-back] or [+back] features		
pò-dókò	*their shirt*	**è-líɽè**	*or* ì-líɽè	*his root*
pè-ʤètím̀	*their lie*	**è-dókò**	*or* ò-dókò	*his shirt*

/ɪ/ and /ʊ/ do not partake in this harmony

pà-bʊ̀nʊ̀	*their goat*
pà-bíjɛ̀	*their stone*

4.1.3 Syllable structures and phonotactics

In African languages, the universal CV is the preferred syllable type. **Onsetless syllables** are often restricted to word-initial positions, if they are allowed at all (Clements 2000). **Coda consonants** (CVC structure) are not frequently attested, and the type of coda consonants is usually restricted (ibid.). In addition, Naden (1989:156) mentions that in Gur languages the CVC structure exists in root forms, although CVCV(CV) syllabification is preferred and thus epenthetic vowels are inserted to avoid coda consonants. Vowel morphemes may occur as pronouns creating the syllable type V, and some particles or affixes are a single C (id.). Syllabic nasals are largely found in African languages; in the Gur subgroup they usually occur in affixes, particles and pronouns (Naden 1989:155).

Word-initial **consonant clusters** are not common in Gur (Bendor-Samuel 1971), and if they occur, they are restricted to a small number of consonants. In southwestern parts of the Gur language area, in obstruent-high vowel sequences the vowel may be deleted, creating consonant sequences, such as tl, tr and bl (Naden 1989:157). Naden does not give any further restrictions, but all his examples are stop plus liquid sequences. However, according to Clements (2000:146), many West African languages have consonant-liquid clusters.

Nasal + stop (NC) sequences are quite commonly attested in Niger-Congo. The phonological analysis of NC sequences in the literature has been a subject to long debate in phonology. In what follows, the basic argumentation is given for the NC sequences analysis in general. The

nasal sound changes are first examined, followed by the NC sequence analysis, which includes syllabification and syllable structure markedness principles.

The articulation of nasal consonants is linked to all parts of the vocal tract, which may explain the complex phonological status of nasals (Ohala & Ohala 1993). Synchronically, the sound segments, including nasal elements, may change and develop from nasal consonants to nasal vowels and again back to nasal consonants. This has occurred during the evolution from Sanskrit to Modern Hindi via Old Hindi, as cited in Ohala and Ohala (1993). In Sanskrit, the word *courtyard* was [aŋgana], in Old Hindi [ã:gana] and in Modern Hindi [ãŋgə̃n] (ibid.:238). In Niger-Congo languages, proto-Niger-Congo is sometimes considered as having nasal vowels rather than nasal consonants (Williamson 1989 and references therein), although Bole-Richard (1985) posits that nasal vowels developed from CVN or CNV sequences. In Niger-Congo languages where NC sequences are relatively common, the hypothesis is that those sequences developed from the syllable structure CṼCV, which later became CṼNCV (Williamson 1989). This tendency has been confirmed at least in Mande and Benue-Congo branches of Niger-Congo (ibid.). Bole-Richard (1985) further argues that nasality in Niger-Congo has been shown to be an unstable feature, as some languages have both nasal consonants and nasal vowels, whereas some languages have only one or another. The author also states that the nasality is mainly a suprasegmental feature in Niger-Congo. Nevertheless, these phonological changes are phonetically plausible because of co-articulation, as the nasal may cause the anticipatory nasalization of the vowel and also a significant part of closure of the stop to be nasalized (e.g. Cohn 1990).

When analyzing NC sequences, it is stated that it is difficult, in fact almost impossible, to make a phonetic difference between prenasalized stop and NC-cluster (e.g. Creissels 1989), or that in some languages there is no phonetic distinction between prenasalized stops and NC-cluster, even if the distinction exists phonologically, or that the distinction is rather between a single nasal versus a geminate nasal that are both followed by a stop (e.g. Ladefoged & Maddieson 1996). Downing (2005) posits that, as there is a lack of phonetic and phonemic contrast between NC-clusters in comparison to prenasalized stops, the segmental position of NC clusters must be established by some phonological arguments. However, some recent studies have revealed that NC-clusters tend to have longer duration than single segments at least in some (Austronesian) languages, but prenasalized stops that are analyzed as single segments are equivalent in duration to other single segments (e.g. Riehl 2008).

Traditionally, many Bantu languages are analyzed as having prenasalized stops that behave as a single unit creating a syllable onset (e.g. Herbert 1986, Downing 2005 and references therein). Downing (2005), however, gives contrary arguments by stating that NC-sequences in Bantu languages are better considered as homorganic clusters belonging to two different syllables. Her arguments include the following facts. In Bantu languages, NC sequences occur mostly

intervocalically and almost never stem-initially, as the initial NC sequences normally belong to two different morphemes. In Bantu, the phenomenon of vowel lengthening before NC sequences occurs, as is the case for example in Jita (Tanzania) where long vowels do not occur in other conditions (ibid.). According to the traditional analysis, vowel lengthening before NC sequence is stated to be compensatory and having the effect that the nasal is syllabified to the following onset; the resyllabification is needed, because only open CV syllables are attested in Bantu. Downing (ibid.) argues that these assumptions are not adequate as there are other languages with vowel lengthening, although there is a nasal in coda position. As a consequence, Downing gives a different argument for vowel lengthening, namely that vowel lengthening is enhanced before a nasal at the same syllable, and that the duration of homorganic NC sequences is usually reduced.

According to Downing's (2005) analysis, the nasal in NC sequences is moraic; it shares the place feature with the following consonant, but it shares a mora with the preceding long vowel. Downing (ibid.) continues by contradicting the syllable structure markedness principle, which is a common argument when analyzing NC sequences as a unique segment. According to previous analyses, if an NC sequence is analyzed as a unit segment, the syllable structure of the language is kept unmarked and simple, as coda consonants are not allowed in Bantu. However, as Downing points out, nasals are high in sonority (e.g. Selkirk 1984) and homorganic nasals lack independent place feature (e.g. Itô 1989), and Downing (2005) states that they are the least marked coda consonants. Many languages also have phonotactic restrictions allowing only coda consonants which share place feature with the next syllable's onset, e.g. a geminate consonant or a homorganic consonant (e.g. Itô 1989). Downing (2005) also cites Vennemann (1988), according to whom word-internal codas are less marked than word final codas. As conclusion, Downing (2005) argues that nasals as codas minimally affect the syllable markedness structure, and NC sequences in Bantu are rather consonant clusters belonging to two different syllables than prenasalized stops. Hubbard (1995) previously analyzed NC sequences in couple of Bantu languages according to the same principles than Downing, as Hubbard considered the nasal of NC sequence to be moraic and thus a part of the previous syllable.

4.1.4 Section summary

In this section, the characteristics of segmental phonologies in Niger-Congo languages were examined, focusing especially on Gur languages. However, it is important to keep in mind that many Gur languages still lack detailed analysis, and for that reason the generalizations may change as more studies are conducted on Gur languages (cf. Naden 1989). The summary table (Table 3) below illustrates the main discoveries of the Gur languages in relation to the Niger-

Congo family. The references for the Gur languages were mentioned previously in the text, and are not mentioned in the table below.

Table 3. Summary table of features in Niger-Congo and Gur languages.

Feature	Attested in Niger-Congo	Attested in Gur (example languages)
Consonants		
Labial flaps	yes	no
Labial-velars	yes	yes, e.g. Dyan
Implosives	yes	yes, e.g. Dyan
Lack of voiceless labial stop	yes	yes (rare), Tem
Lack of contrastive nasal consonants	yes	yes, e.g. Buamu, Naténi
Vowels		
Length distinction	yes	yes, e.g. Dagaare
Nasal vowels	yes	yes, e.g. Kassem
Diphthongs	yes	yes, e.g. Kɔnni
ATR-harmony	yes	yes, e.g. Kassem
height vowel harmony	yes (Bantu)	no
Other vowel harmonies	yes	yes, e.g. Supyire (multiple harmony)

Syllable structures are simple in Gur. Vowel onsets are mainly initial. Consonant clusters in Gur are restricted to certain type of consonants, especially nasal plus stop sequences or stop plus liquid sequences. Many Niger-Congo languages originally had CVCV-roots (cf. Williamson 1989), which may explain the simple structures.

In general, it is possible to postulate that Gur languages seem to have the same segmental characteristics as those typically attested in the Niger-Congo family. In the next section, tonal phonologies in Niger-Congo and Gur will be examined.

4.2 Tone

Tone is defined by Hyman (2001a:1368) as follows: “A language with tone is one in which an indication of pitch enters into the lexical realization of at least some morphemes”. In other words, tone changes the meaning of the word, as a phoneme does. This is seen in (59) below, where four lexical items consist of the same segments /kua/, but the lexical meaning alternates

depending upon the tones that the segments bear. Tone can also be a morpheme, and it can do everything a morpheme does (Hyman 2011:204).

(59) Samue (Gur, Burkina Faso)

kūá	*calabash*
kúá	*market*
kúà	*lake, pond*
kùá	*enemy*

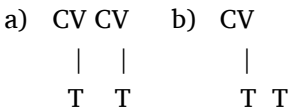
As mentioned by several authors (e.g. Odden 1995, Clements 2000), the most outstanding characteristic of tones in African languages is their independence with respect to the segments on which they are realized. However, as Yip (2002:140) states, not all African languages are typologically uniform in all typical characteristics of tone. In this section some fundamental tonal processes are discussed and illustrated by examples from Gur languages, when applicable.

4.2.1 Autosegmental representation of tone

Tone is independent from the segments on which it is realized; this was mentioned already by Pike (1948). The autosegmental nature of tone was already taken into account in early 1970s, for example Leben stated (1973:25) that "tone does not uniformly behave like a segmental feature in languages, that sometimes it exhibits behavior that must be characterized as suprasegmental". Soon afterwards Goldsmith (1976) developed his revolutionary theory of autosegmental phonology in his thesis that was mainly motivated by tonal phenomena in African languages.

The fundamental idea of autosegmental representation is that there are two or more parallel tiers, separately for segments and prosodic material (Goldsmith 1990). Connecting lines between the tiers mark how tones are associated to the segmental tier as in (60). A tone (T) is realized only if it is associated with a segmental or prosodical item (mora, μ, or syllable, σ). The association lines show that connected segments and tones are phonetically realized at the same time. The second tone of b) example in (60) is not associated to a segmental unit, which means that is not realized.

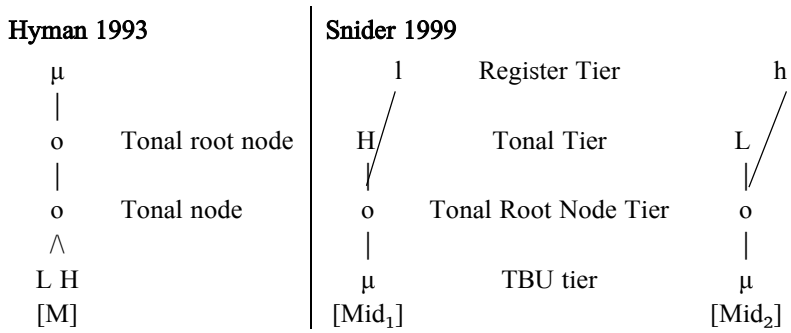
(60) Autosegmental representation



Goldsmith (1990) posited well-formedness conditions and an association convention that are to be respected in autosegmental representation. Originally the author talked about vowels in relation to the Tone-Bearing Unit (TBU, see more in the following section). The following statements are modified according to Yip (2002), who used TBU instead of vowels. The well-formedness conditions are the following: 1) every TBU is associated with at least a tone, 2) every tone is associated with at least a TBU, 3) association lines do not cross. The association convention states that association is one-to-one from left to right. However, as Yip (2002) argues, not all of these conditions are universal and respected in all languages. There are languages that leave tones unassociated (i.e. floating), and in some languages tones spread, but other languages have toneless syllables. Also contour tones may appear in word final positions, but also word medially; i.e. the association is not always one-to-one and left-to-right.

In addition to the autosegmental representation, tonal behavior has been analyzed by different representations of tonal tiers, especially in relation to discussion about tonal features or tonal registers. Metrical trees were used by Clements (1981) with two levels: tonal foot level and lexical tone level. Hyman (1993) proposed a feature geometry approach to tonal processes with a tonal root node and a tonal node. Register Tier Theory by Snider (1999) has a third level, namely a register tier. In this study, these theoretical approaches are not discussed in detail; see section 4.3 for tone features. In (61), the representation of a mid tone is given according to Hyman and according to Snider. Snider's (1999) proposal includes two different types of M, depending on the register tier which the tone belongs to.

(61)



Autosegmental representation is a practical way to illustrate how tones are associated to segments, even if all the well-formedness conditions are not respected in all languages. For this concrete reason, autosegmental representation is used in the present study to demonstrate tonal processes, although the theoretical importance is placed on Optimality Theory.

4.2.2 Tone-Bearing Unit

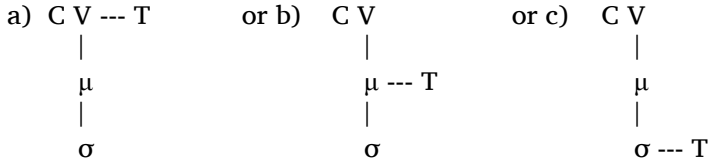
In tone notation, tone is usually associated with vowels, sometimes with other segments, most often syllabic nasals or laterals. In phonological terms, it is necessary to determine what a Tone-Bearing Unit (TBU) in a particular language is: segment, mora or syllable.

Yip (2002:73-74) gives possible outlines for TBU, schematized in (62) by autosegmental representation. 1) If a language has only monomoraic open CV syllables, TBU may be the vowel, mora or syllable. 2) Sometimes syllabic nasals are moraic and will bear tone, but onset nasals do not. In that case the segment cannot be the TBU, but the mora or syllable can. 3) If the language has both light monomoraic and heavy bimoraic syllables, which both obligatorily bear a different number of tones, then the TBU is the mora. For example the melody high-low is realized [káàkà] when the first syllable is bimoraic, but the same melody is realized [kákà] when the first syllable is short. 4) The syllable must be the TBU, if two different syllable weights are able to bear the same number of tones. The high-low melody will then realize as [káákà], if the syllable is the TBU.

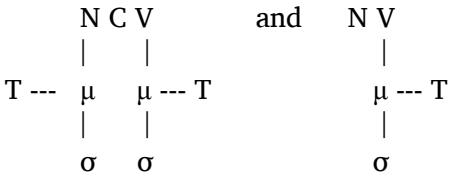
As Yip (2002:74) mentions, tone seems to be associated with prosodic entities, i.e. mora and syllable. There is no language in which the TBU has to be a segment (ibid.). Nowadays, researchers accept that the TBU varies from language to language and can be the mora or the syllable. Previously, there were arguments that favored the syllable-based theory, which, nevertheless, could not explain the behavior of tones in languages that count moras (see e.g. Odden 1995). There are suggestions that the syllable might be the typical TBU in the geographic region of Gur languages (e.g. Cahill 2007a). However, there are some contradictory studies in this regard (e.g. Roberts 2005).

(62) TBU-structures

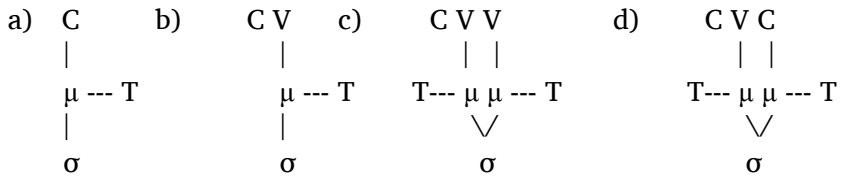
1) TBU may be segment, mora or syllable if language has only CV syllables:



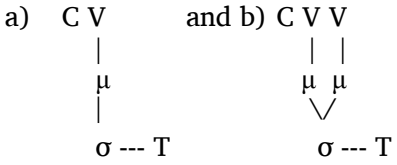
2) TBU is mora, not segment:



3) TBU is mora if different syllable types bear different number of tones:



4) TBU is syllable if different syllable types bear the same number of tones:



4.2.3 Tonal systems

Tone languages can be classified in different groups. Pike (1948) already makes a distinction between contour vs. register tone systems. As Hyman (2001a) reviews, contour systems with rising and falling tones are mainly found in Asia, while African languages are typically **register languages**, where the basic unit is the tone level. In register systems, contour tones may be present, but they are analyzed as a combination of level tones. The number of contrasting level tones may be up to four or five, although two- and three-tone systems are more common than four-tone systems (Yip 2002:26). A few languages are reported to have five level tones, for example Benchnon (Omotic, Ethiopia) (Rapold 2006), but some researchers doubt the existence of the fifth level (e.g. Hyman 2001a:1369), while others state five-tone systems only to be very rare (Yip 2007:231).

Accentual languages are considered as a subtype of tone languages, but they contrast only a small number of tones (one or two), which are distributed in a very restricted way (Yip 2002). Many African languages also have only a two-way tonal contrast, which has a phonetic contrast between high [H] and low [L], but phonological contrast between /H/ versus /Ø/, absence of tone. In this kind of systems, only high (H) is active, and toneless syllables are supplied by a low (L) tone in the surface, i.e. H is the specified tone. In some systems, L is the specified tone (Yip 2002:25-26, 133). When tones are distributed in this restricted way, they are sometimes called accentual, instead of tonal as such. Accentual systems are quite common in Bantu languages where high tones are attracted to the head syllable of the word, which is often the penultimate syllable, no matter where the tone originally arose (Yip 2007:243, Odden 1995:470-473). The description of tone by Hyman (2001a) as cited earlier includes accentual languages, as Yip (2007) remarks.

The majority of African languages are tone languages, and virtually all Niger-Congo languages are tonal. African languages have rich **tonal inventories**. The most typical tone system in Niger-Congo languages opposes two distinctive tone levels, H and L (Clements 2000), although some contrast up to four tones, or five (see above). Tone levels may be accompanied by contour tones. Naden mentions (1989:155) that the analyses of tone for Gur languages have revealed systems varying from two-tone systems to system with four levels with different tonal processes. One Gur language is reported to be non-tonal, namely Koromfe (Rennison 1997).

Tone has both **lexical and morphological functions** in Niger-Congo languages. According to Naden (1989:155), in Gur languages tone has a heavier grammatical load than lexical load. As a whole, Naden considered the Gur language tonal systems to be poorly documented (id), in comparison with Bantu languages, which have given rise to a considerable amount of literature (Yip 2002:132). Some research has been done since Naden's article in 1989. However, tone is analyzed to a different extent in each of these works, i.e. the whole tonal system is not necessarily thoroughly examined (e.g. Akanlig-Pare & Kenstowicz 2002, Anttila & Bodomo 2000, Cahill 2007a, Carlson 1994, Neukom 2004, Roberts 2002, 2003, 2004, Schwarz 2003, Somé 1998, 2003, Wichser 1994). As a whole, many Gur tonal systems are yet to be analyzed.

4.2.4 Phonetic tonal processes

The universals of tone rules were first introduced by Hyman and Schuh (1974) based on West African languages, and these rules further divide tone systems into typologies. Hyman & Schuh (ibid.) divide rules into 1) natural diachronic tone rules and to 2) natural synchronic rules, which Hyman (1975) modified slightly and made terminological changes: 1) phonetic tone rules versus

2) morphophonemic tone rules. In 2007, Hyman revisited the rules and found that they are largely applicable, with some minor revisions, also to other than West African languages.

In the present study, the tonal processes refer to what Hyman and Schuh (1974) called tone rules. I mainly follow the classification by Hyman and Schuh, but I also consider how Yip (2002) determines the characteristics of tone, especially in African tone languages. The phonetic tone processes that refer to simple processes of natural sound change are discussed next, including the possible interaction between tone and laryngeal features.

4.2.4.1 Downdrift

In this study, downdrift is described as in Hyman (1975). According to Hyman (id.), downdrift is a process where every H (or mid) tone after every L tone is automatically lowered, and every L tone may be lowered too, so that the realization of tones is quite different depending on where they are located in the utterance, see (63). Thus, a later H in an utterance may be at the same level as an earlier L. This phenomenon is also called a terrace-level tone system, and it is well documented in African languages (e.g. Clements 1979, Hyman 2001a), and attested also in Gur languages (Naden 1989). Sometimes, downdrift is also called automatic downstep (e.g. Hyman 2001a, cf. 4.2.5.1 for downstep).

(63) Downdrift

H L H L H L H

[¯ – ¯ _ – _ –]

4.2.4.2 Vertical assimilation

A related phenomenon to downdrift is vertical assimilation, where adjacent L and H tones undergo **raising** or **lowering**. Vertical assimilation is merely considered as an adjustment of pitches down- or upwards. For example, L tone in L-H sequence may be subject to anticipatory raising and the sequence will be M-H. In the same way, perseverative lowering changes H to M in the same L-H sequence. In (64), common processes are called natural and uncommon processes are called unnatural (Hyman 2007:3).

(64) Raising and lowering by Hyman (1975:222)

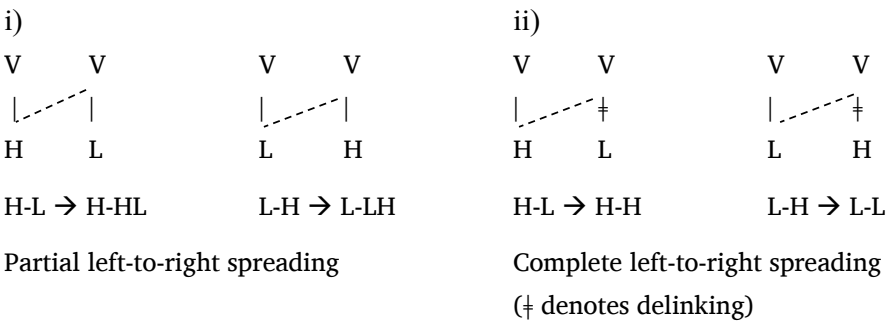
Natural	Unnatural	
L-H → M-H	H-L → H-M	(raising)
L-H → L-M	H-L → M-L	(lowering)

4.2.4.3 Horizontal assimilation

Horizontal assimilation refers to tone **spreading** onto a neighboring TBU. As Hyman and Schuh (1974) already mention, spreading is the most basic tonal process. According to Hyman (1975:223) spreading is natural when the phenomenon is progressive (or perseverative), i.e. it is realized from left to right. Right-to-left spreading is much less natural. It may occur, but it is more restricted and its motivation comes at least partly from the attraction to specific metrical positions (Hyman 2007:18-27).

Spreading can be partial or complete, see examples in (65) by autosegmental notation as in Hyman (2007:5). H tone is the most probable tone to spread. Spreading first alters tones that are maximally different (e.g. H and L), and only in the second place tone levels close to each other (e.g. L vs. M, or M vs. H). Tone spreading may also be bounded, and concern only one TBU, or more rarely two TBUs, to the right of the tone. It can also be unbounded, and concern several consecutive TBUs as in (66), not only one (Hyman 2007:8).

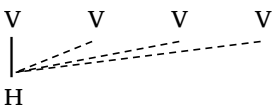
(65) Progressive i) partial and ii) complete spreading



Partial left-to-right spreading

Complete left-to-right spreading
(ǂ denotes delinking)

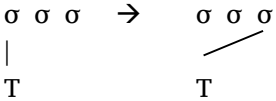
(66)



Non-bounded spreading

Tone shifting or **displacement** can be seen as a kind of spreading. In this case, tone is not simply spread, but it is relocated to a new TBU, which is adjacent or more distant from the point of origin as in (67). This character of the tone is called also **tonal mobility** (Yip 2002). Yip considers mobility as the most striking phenomenon in African tone languages.

(67)



Tonal mobility is especially frequent in Bantu languages. Digo (Kenya, Tanzania) is a Bantu language where verbs have different prefixes for subject, object or tense markers (Yip 2002:134-135, from Kisseberth 1984). A H tone moves several syllables away and surfaces on the last two syllables, no matter whether the H originates on the root or on an object prefix or on a subject prefix. This is because of the alignment constraint that requires H to be aligned with the head foot in Digo. In (68), tonal mobility is illustrated according to Yip (id.). The verb roots are marked in bold. An underlined a is an object-prefix in c), and subject prefix in d). Both prefixes bear H tone. This high tone marked by underlining is realized only several syllables later, as marked by accents: rising low tone followed by a falling high tone.

(68)	ku-**arŭ**k-â	*to begin (high-tone root)*
	ku-**vugur**-ir-a	*to untie for (toneless root)*
	ku-a-**vugur**- ĭr-â	*to untie for you/them (with a H object-prefix a)*
	a-na-**vugŭ**r-â	*he is untying (with a H subject prefix a)*

In some languages, the L tone is raised to H when it appears between H tones, because HLH sequences are prohibited. This phenomenon is also called **tonal plateauing** (Hyman 2001a:1374). For example, in Kɔnni (Gur, Ghana), HLH sequences are not allowed, as Cahill (2007b:7) reports. When the H-toned definiteness morpheme is added to HL-stem, H-tone spreads leftwards delinking L-tone, which will lower the following High causing a downstep as illustrated in (69) according to Cahill (id.) (see more on downstep in 4.2.5.1).

(69)

ŋórà *chests*				ŋó꜒ráhá *the chests*
H L	H			H L H
| |	|	→		| /\
ŋʊ r a +	ha			ŋʊ r a h a

4.2.4.4 Contour simplification: absorption, leveling

Tone contours are often restricted according to the kind of syllables they are found in (heavy vs. light), and where in the word this syllable must occur. Word final contours are more typical (Yip 2002:28), and long vowels are most likely to bear contour tones (Gordon 2001:405). Contours may be simplified, if the receiving TBU does not easily host a contour, for example if the syllable is CV instead of CVV.

Contour simplification is divided in two types by Hyman and Schuh (1974:90-92): a) **leveling** where a contour is converted into level tones, and b) **absorption** as in (70), which occurs when a

contour tone has an adjacent like tone, i.e. tone identical to the end/starting point of the contour. Languages may prohibit contours in like or unlike neighbor contexts.

(70) Absorption schematized according to Hyman (2007:9)

Natural	Unnatural
LH-H → L-H	L-LH → L-H
HL-L → H-L	H-HL → H-L

4.2.4.5 Tone and segmental interference

The interaction between tone and laryngeal features in African languages can be found with **depressor consonants**. Usually voiced obstruents lower the tone of neighboring high tones. They may also block the spreading of H tone and H-tone plateauing (Yip 2002:157). Bradshaw (1999) has shown that depressor consonants effecting tones are typical in African languages and rare elsewhere. Some Gur languages are also reported to have depressor consonants, e.g. Dagara (Somé 1998).

An example of depressor consonants in Dagara (Gur, Burkina Faso) is given by Somé (1998:10-11): when a noun phrase is composed of two elements whose second stem is juxtaposed to high tone nominal stem **ní**, *person*, the high tone of **ní** spreads to the following stem. The tone of the second stem is L plus floating high in examples, but the behavior of the floating tone is not discussed here. The H-spreading does not occur, when the second stem has a depressor consonant in the initial position as shown in the right column of (71). Somé (1998:13) calls the depressor consonants "opaque"; they include voiced obstruents.

(71) Depressor consonants' effect in Dagara (Some 1998:10-11)

ní + non-depressor		***Gloss***	**ní + depressor**		***Gloss***
ní + sàal´	→ **ní sáál̀**	*human being*	ní + vlà´	→ **ní vlà**	*good person*
ní + yàal´	→ **ní yáál̀**	*ridiculous*	ní + zìɛ´	→ **ní zìɛ̀**	*person with a light skin color*
ní + plàa´	→ **ní pláà**	*white person*	ní + gbòlo´	→ **ní gbòlò**	*fat persons*

4.2.5 Morphophonemic tonal processes

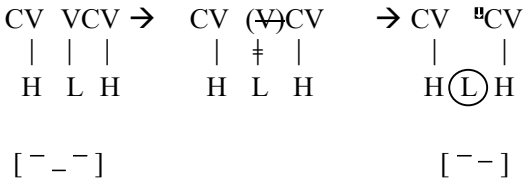
The second group of tonal processes examined in this section includes morphophonemic processes. Some fundamental issues about the morphophonemic processes of tone are discussed next, categorized by tonal processes according to Hyman (1975, 2007), and also considering Yip

(2002). Morphophonemic processes include downstep, dissimilation and polarization, copying and replacement.

4.2.5.1 Downstep

Downstep is a tonal process where a high tone is lowered, because it is affected by a low tone that has lost its original segment, and the L tone is no longer associated to any TBU. This low tone becomes a **floating tone**, which modifies the adjacent high tone while failing to surface itself. Downstep is most often found in languages which contrast two tones (Yip 2002:149). Downstep is illustrated by autosegmental notation in (72) where the floating low tone is denoted by a circle, and also by a superscripted down arrow. The superscript down arrow means that an H following the floating L is realized in a lower downstepped level in comparison to the previous H. L tone is left floating because its TBU-segment is deleted.

(72) Downstep



Additionally, a HLH-sequence may engender downstep, if the first H spreads rightwards having the result HH$^{\downarrow}$H, or the last H spreads leftwards, resulting as H$^{\downarrow}$HH (Hyman 2011:18). Downstep may occur also without a floating tone. Odden (1986) argues that sometimes downstep occurs without the presence of any L tone, as is the case in Kishambaa (Bantu, Tanzania), where two adjacent H tones are not realized on the same high level, but the second one is downstepped. This type of downstep does not occur, however, when one H tone is associated to several vowels.

Downstep is a frequent phenomenon in African languages (Yip 2002:133), and it is attested also in Gur languages (Naden 1989). The inverse phenomenon, upstep, is also attested in some languages (Yip 2002:150). A floating tone can be lexical or grammatical. Somé (1998, 2003) analyzed Dagara (Gur, Burkina Faso) having both low and high lexical floating tones, which he refers to as a tone non-realized in an isolated context (Somé 1998:61, 73-74). Examples in (73) show nouns with a low floating tone that triggers the downstep on the following word, but in isolation the floating tone does not surface. In comparison with closely related languages, it is possible to assume, that in Dagara, the origin of the lexical floating tone arises at least to some extent from suffix morphemes whose segments have been partially or completely deleted (ibid. 78).

(73) Lexical floating tone in Dagara

In isolation	**Input form**	***Gloss***
lú	lú`	*chick*
sól	sól`	*tail*
gùrú	gùtú`	*mushroom*
gbàá	gbàá`	*snake*
In noun phrase		
lú` + kórá	→ lú ˡkórá	*old chick*
sól` + kórá	→ sól ˡkórá	*old tail*

A case of grammatical floating tone is found for example in Kɔnni (Gur, Ghana), where the associative marker for third person (e.g. their stick, child's stick) is a segmentless H tone (Cahill 2007a:313). A segmentless H tone surfaces on the first tone of the head noun as in (74). Since the L tone of the first syllable is left floating, the second H tone is downstepped.

(74)	a)	dàáŋ	*stick*	tì dàáŋ	*our stick*
	b)	bà dáˡáŋ	*their stick*	bʊ̀áwá dáˡáŋ	*child's stick*

Downstep can be seen as **tone preservation or stability**, because if a segment is deleted, the tones which it bore are not deleted; they become floating tones. Tone preservation is seen also in other contexts than downstep as Yip (2002:67) illustrates. If a segment reduplicates, the tone may not be copied, or if a vowel deletes, the tone may remain, causing contour tones or other tonal modifications, not necessarily always a floating tone.

4.2.5.2 Dissimilation and polarization

Tones may also undergo **dissimilatory** processes, although they are considered less frequent than assimilatory processes. For example, H-L intervals have shown to be often subject to dissimilation: a H preceding a L is raised to superhigh (Hyman 2007:3). Hyman (2001a:1375) discusses dissimilation and thinks that it may be motivated because it will create more tonal space for eventual downsteps occurring later in the utterance.

Polarization is a process where adjacent TBUs have opposite tones, i.e. a noun stem having a L tone will receive a H tone suffix, or a H tone stem will receive a L tone suffix. Polarized affixes are sometimes analyzed as being toneless (cf. Yip 2002:159-161).

Polarity is a frequent phenomenon in African tone systems, but it is particularly common in Gur languages (Yip 2002:159). Polarity in Moore (Gur, Burkina Faso) was analyzed by Kenstowicz, Nikiema and Ourso (1988), and their conclusion is that tonal polarity is an

epiphenomenon due to tonal dissimilation; most typically an underlying H undergoes dissimilation. However, Cahill (2004, 2007) posits that in Kɔnni (Gur, Ghana) polarity is morpheme specific in a particular noun class: noun class 1 plurals exhibit tonal polarity. Consequently, a plural suffix surfaces always with an opposite tone in comparison with the tone of the stem as shown in (75) below, although in other classes the plural suffixes tend to be H-toned. Other noun classes in Kɔnni do not show polarity. Cahill demonstrates (2004) that the noun class 1 plural suffix is not underlyingly H or L, but it is polar; some of the data is illustrated below in (75).

(75) Tonal polarity in Kɔnni noun class 1 (Cahill 2004:14).

singular	**plural**	**stem tone**	**pl.suffix tone**	***gloss***
sí-ŋ	sí-à	H	L	*fish/es (sp.)*
bììs-íŋ	bììs-á	L	H	*breast/s*
tíg-íŋ	tíg-è	H	L	*house/s*
zùnzú-ŋ	zùnzú-à	LH	L	*maggot/s*

Dissimilatory and polarization processes may be analyzed as being motivated by the **Obligatory Contour Principle** (OCP). Leben (1973) proposed this principle according to which adjacent identical elements are prohibited. Later Odden (1986) argued that OCP may not be a universal constraint. According to the OCP, sequences of high tone syllables for example are better represented as in (76) a), not as in b).

(76) a) b)

4.2.5.3 Copying and replacement

Hyman and Schuh (1974) defined tone **copying** as a process where a toneless element, e.g. a pronoun, receives a tone from the adjacent TBU. Thus it will produce a L tone in contact with another L tone and H tone in contact with another H tone. The same authors (1974:102) talked also of tone **replacement**. It is a frequent phenomenon when tone has grammatical functions. Thus, an underlying tone of the verb stem may be replaced, when tense or aspect is marked by tone, and that changes the tone of the verb.

In Dagbani (Gur, Ghana), two level tones are contrastive in verb roots (Hyman & Olawsky 2004). However, this opposition is replaced or neutralized for example in the future tense, which is H-toned. Imperfective on the other hand is expressed with an LH pattern. It can be stated

(ibid.) that in Dagbani, the role of the lexical tone is reduced in verb paradigms by partial tone replacement.

4.2.6 Section summary

This section on tone has discussed tonal systems attested in Niger-Congo languages, as well as tonal processes commonly found in the languages of the African continent. Special attention was directed to the Gur languages. In this review section, the characteristics of tonal systems in Gur are summarized. As mentioned earlier in relation to segmental phonologies and also to the studies of tonal systems in Gur, many languages are still in need of a detailed description, and thus the characteristics mentioned here may be modified if new studies in Gur reveal some other typical phenomena.

Gur language tonal systems vary from two-tone systems to four-tone systems, and both syllable and mora are attested as TBU. The same type of variation is found largely in the Niger-Congo family. The phonetic tone process of **downdrift** is found in Gur languages. **Depressor consonants** affecting tonal processes are also present; they seem to be very common across the Niger-Congo languages (Williamson 1989).

The tonal process of **spreading** is a very frequent phenomenon in Gur, as in tone languages in general (e.g. Hyman & Schuh 1974). Downstep was first reported in Niger-Congo languages (cf. Williamson 1989), and it is also common in Gur. Polarization, i.e. the process where adjacent TBUs obligatorily have opposite tones, is attested in Niger-Congo, but it seems to be especially well reported in Gur (Yip 2002).

As previously stated, tonal systems largely vary in Niger-Congo languages, and several tonal processes are attested. In the Gur family, the same tonal characteristics are found. Most languages that are reported to have **tonal polarization** seem to belong to the Gur family; however, polarization is not attested across all Gur languages.

4.3 Segmental versus tonal phonology

Speech segments are often analyzed in terms of features. Tone and tonal behavior are not necessarily well analyzed with tonal features, because the nature of segmental and tonal phonologies are so distinct. In what follows, some basic differences that are found in segmental versus tonal phonology will be discussed.

Speech sounds or segments are composed of features. Jakobson, Fant and Halle (1963:3) defined **distinctive features** as “the ultimate distinctive entities of language since no one of them

can be broken down into smaller linguistic units. The distinctive features combined into one simultaneous or […] concurrent bundle form a phoneme". Distinctive feature theory was further developed by Chomsky and Halle (1968) who posited the universal nature of features. Each feature has a distinct phonetic (articulatory) definition. Consonantal segments are traditionally described by features related to place of articulation, manner of articulation and voicing. Vowel features refer mainly to the use of vowel space (front/back, high/low) and to roundness.

When analyzing features, some basic requirements for evidence should be filled, which Clements, Michaud & Patin (2010:5) summarized to include phonetic motivation, recurrence across languages, formal simplicity, and comprehensiveness. In his definition of tone, Hyman (2001a) intentionally did not include any requirements of features to be present. The **development of tone features** has not been as successful as that of segmental features, because the basic criteria of feature analysis could not be satisfied (Clements et al. 2010:5-6).

Clements et al. (2010) argue that the **basic unit in tonal analysis is the simple tone level** without universal tone features, but language-particular tonal features may occur and be motivated in some languages. They arrive at this conclusion, because the nature of tones is different from segments. Furthermore, the authors cannot find enough evidence that a traditional two-feature model with highs and lows could describe tonal assimilation processes. Yip (2002:65), who supports the model of tone features, gives a list of characteristics that are rarely or never found in consonantal or vocalic features, but exist in tonal phonology. Most of these characteristics were already discussed above.

- tonal mobility: movement of tone away from point of origin
- tonal stability: survival of tone after loss of original host segment
- one-to-many: a single tonal feature shared by two or more segments
- many-to-one: multiple tonal features surfacing on a single host segment
- toneless segments: potentially tone-bearing segments that have no lexical tone

Hyman (2010:71) argues that the **nature of tones** does not correlate to a feature system in the same way that consonant and vowel segments do. The tone's diversity and autonomy is such, that it is distinct from segmental phonology. He further posits, that "tone can do everything segments and non-tonal prosodies can do, but segments and non-tonal prosodies cannot do everything tone can do" (Hyman 2011:214). As consequence, Hyman (2011:236-238) proposes another list of characteristics of tone. According to him, compared with other phonological properties, tone is the most **syntagmatic** with its movements, the most **paradigmatic** because it is able to create many contrasts along a single F0 dimension, the most **analytically open-ended** enabling a wide range of reasonable analyses and interpretations, the most **abstract** having indirect input-output relations, the most **arbitrary** in its alternations and the most **autosegmental** because of its independence related to the TBU.

Hyman (2010:74) states that tones are best considered "as privative elements that are related to each other through their relative and scalar phonetic properties". The author's statement is in line with Clements et al. (2010) who argue that tone levels are sufficient for tonal analysis. As seen above, some contrary opinions exist as to how to examine tones in terms of features (e.g. Yip 2002). In this study, nevertheless, the tonal system of Samue is not analyzed with tonal features. The analysis is limited to tonal processes found in the language without feature analysis. Within the description of segmental phonology, phonemes are defined by traditional features, and segmental features are taken into account in phonetic contexts where segmental and/or tonal alternations do occur. Featural organization of sound segments is mainly based on the model of Feature Geometry (Clements & Hume 1995), although the weight of the analysis is on Optimality Theory concepts of language structures, which are revealed by output constraints. The principles of Optimality Theory are the topic of the next chapter.

5 OPTIMALITY THEORY

Optimality Theory (henceforth OT) has, in a very remarkable way, influenced linguistic research since 1993 in its different domains. Prince and Smolensky presented their new approach to language in a well-known manuscript *Optimality Theory: Constraint interaction in Generative Grammar,* which was published in 2004. OT is not used only in phonology, but also in other linguistic domains, such as syntax, semantics, and pragmatics. As de Lacy (2007:21-22) indicates, OT is merely a framework, divided into several sub-theories.

In this dissertation, OT is used as the main theoretical framework, with a focus on the phonological application of OT. OT principles are presented in this chapter in their standard forms, as introduced by Prince and Smolensky (1993/2002) in their revised version of the original 1993 manuscript, and sometimes based on the explanations by McCarthy (2002, 2007 & 2008). The first section gives a background and the motivations of OT. The subsequent sections outline the basic components of the theory, such as Generator, Evaluator and Constraint components, and how these components function together in the Grammar. The chapter ends in an outline of some OT applications that are widely used in phonological and tonal analyses.

5.1 Background and motivations

Optimality Theory has its roots in the tradition of Generative Grammar, which was a mainstream in phonology for a long period of time. Chomsky and Halle's (1968) famous *The Sound Pattern of English* (henceforth SPE) presented a rule-based derivational phonology in terms of Generative Grammar. It is centered on the ordered rewrite rules that describe phonological processes. In the representational dimension, SPE represents a linear arrangement of segments, which are considered to consist of universal distinctive features (see chapter 4.3). There are no representational constraints; the description is merely structural. According to SPE, rules with few features have a greater explanatory value because they are more natural than rules requiring more features. However, SPE rules as a formal system are not able to define how phonological systems are constructed and which kinds of systems are possible in natural languages (e.g. Anderson 1985, McCarthy 2008). In their final chapter, Chomsky and Halle (1968) themselves

admit that their formulation of a linguistic theory is overly formal and inadequate, and they suggest some improvements by a theory of markedness.

Nonlinear phonology, which developed partly as a response to linear phonology, includes a family of different phonological theories, such as Autosegmental phonology (Goldsmith 1976), Feature geometry (Clements 1985), Metrical phonology (Liberman & Prince 1977), and Dependency phonology (Anderson & Jones 1974). Nonlinear phonology concentrated on the study of phonological representations, shifting away from segments to larger units, such as the syllable and foot. As a consequence, phonological representations became more complex than in SPE. Despite their divergence, all the nonlinear phonologies shared the basic assumption that phonological representations must be more detailed, and that phonological representations of intra- and suprasegmental phenomena cannot be restricted only to linear sequences of segments and their boundaries (e.g. Durand 1986).

Phonological representations became more elaborated while the rules became simpler. In this situation it was "possible to imagine an almost ruleless phonology in which automatic satisfaction of universal constraints on representations was all that mattered" (McCarthy 2002:6), and thus rules became trivial, as Goldsmith (1995:7) formulates it. However, as McCarthy summarizes (2002:53), three fundamental problems were found in phonological constraints. First, the proposed universal constraints were found to apply differently in different languages and within a language, i.e. they were not really universal. Second, constraints were recognized to be fully active in some contexts, but only partially in some other contexts. For example, onsetless syllables may be completely impossible in some languages, but in some other languages they are merely avoided, as McCarthy (id.) states citing Itô (1989). Besides these two fundamental problems, the third so-called conspiracy situation of representational constraints is nevertheless the most challenging part for nonlinear phonology, because constraints can both block and trigger rules (McCarthy 2002:53). This third problem is analyzed in more detail below.

It has been recognized for a long time that output constraints affect phonological processes; the two main constraint interactions are blocking and triggering (e.g. Prince and Smolensky 1993/2002). **Blocking** is a process where a constraint blocks the rule to operate in a specific condition, so that an undesired output form is avoided. Deletion rules are often blocking rules (see Kisseberth 1970 for an early reference). Rules can also be **triggered** by output constraints, so that rules are applied only when they are needed to avoid output violations (e.g. Sommerstein 1974, Kisseberth 1970). Epenthesis is a typical triggering case; for example, a vowel is added to satisfy a word structure constraint. Together, blocking and triggering lead to a conspiracy situation.

Conspiracy refers to an output configuration involving several operations which may participate in conspiracy by applying or failing to apply. A classic example from Yawelmani

Yokuts (Yokutsan, United States) illustrates conspiracy, as presented by Kisseberth (1970), who first argued that generative rewrite rules miss an important generalization about the specific role of surface-structure constraints. In Yawelmani Yokuts (Kisseberth 1970), several phonological processes are involved to serve a similar goal as they actively eliminate or passively fail to create consonant clusters with three consonants (CCC), and thus enable only the permitted syllable structure CVC. For example, vowels normally delete in a final position, but a final vowel does not delete after a consonant cluster, because deletion would create a too complex syllable or leave a consonant unsyllabified. Another rule produces a vowel epenthesis in order to avoid three consonant clusters in the middle of the word. These processes can also be stated by a SPE-style rewrite rules (such as V → ∅ /VC_# and ∅ → i/C_CC), but as Kisseberth (1970:299) mentions, final vowel deletion is not able to create bad syllables in surface forms, while epenthesis eliminates bad output configurations. Kisseberth (1970) proposed a solution to conspiracy by modifying rewrite rules and by introducing *derivational constraints* that specify output configuration. Yawelmani has a derivational constraint prohibiting sequences like CCC, #CC and CC#. Obligatory rules in Yawelmani apply in the case where the structural description of the rules is satisfied and the output does not in violate the derivational constraint. In consequence, a rule like V → ∅ /VC_CV can be reformulated as V → ∅ /C_C, because the output must not violate the derivational constraint prohibiting cluster sequences.

Traditional phonological or syntactic theories have had difficulties in formally expressing how triggering and blocking relationships between the processes and the output constraints function. In SPE, there are no representational constraints and thus there is no possibility of recognizing triggering or blocking, nor is it possible to connect the rules existing in a grammar or posit output targets (McCarthy 2002:53). Moreover, Kisseberth's (1970) proposition was incomplete, since he only considered blocking in his explanation, and did not address triggering, which includes processes such as epenthesis, as Kiparsky (1972) mentioned only a couple of years later. Kiparsky (id.) criticized the adequacy of derivational constraints as explanatory theories. Some other propositions were also made. Sommerstein (1974) introduced simplified rules related to the phonotactically motivated rules trying to formulate the phonotactic targets of the phonological rules. Chomsky and Lasnik (1977) initiated a model of filters that restrict the relationship between deep and surface structures, but its influence spread mostly to syntactic analysis.

The conspiracy problem was never fully resolved in the 1980s and 1990s before OT, although some progress was made using syllable structure (McCarthy 2002:54). By the end of the 1980s, there was a consensus about the importance of output constraints, but many unresolved questions remained concerning the nature and activities of the constraints (McCarthy 2008:6). Prince and Smolensky (1993/2002) posit that previous linguistic theories had not given clear answers to the interaction between well-formedness constraints and the relationship between those constraints

and operations they are intended to influence. This ambiguity had, according to Prince and Smolensky (ibid.), lead to "a kind of conceptual crisis at the center of phonological thought" (1993/2002:1). The authors (ibid.:23) further assert that a theory of constraint-domination can lead to a better understanding about these inadequately explained issues in phonological theory, such as triggering and blocking. This can be called an intellectual context, where OT was created with a goal to be able to explain "the way that representational well-formedness determines the assignment of grammatical structure" (Prince & Smolensky 1993/2002:1).

5.2 The core of Optimality Theory

In OT terms, a grammar consists of well-formedness constraints and of possible ways to resolve conflicts that arise between the contradictory demands of different constraints; the conflict resolution is achieved by the means of constraint hierarchy (Prince & Smolensky 1993/2002). The basic structure of a grammar in OT terms is schematized in (77). For a given input, the Generator (GEN) generates a whole set of possible output forms, which is called a candidate set. The Evaluator (EVAL) chooses the most harmonic output form of the candidate set, which will then be the actual output. The selection of the EVAL is based on the constraint hierarchy of the particular language. In what follows, these fundamental components of OT are examined in more detail to explain how a grammar functions.

(77) Structure of Optimality-theoretic grammar (from McCarthy 2002)
/input/ → Gen → {$cand_1$, $cand_2$ …} → Eval → [output]

5.2.1 Universal Grammar and well-formedness

Prince and Smolensky (1993/2002) further posit that a phonological theory must be dependent upon well-formedness constraints, and must also be committed to Universal Grammar. Universal Grammar provides the very substance (i.e. the vocabulary or the inputs) that grammars are built from. In terms of OT, **Universal Grammar is formed of a set of general constraints on representational well-formedness**.

The representational system that is used in OT sustains two classes of essential constraints. The first type is concerned with output configurations and the second with faithful correspondence between the input and output structures. Input and output approximate the concepts of underlying and surface structures that were used in Generative Grammar. OT further asserts (Prince & Smolensky 1993/2002) that **constraints that are active in a language conflict**

largely among themselves, and thus they have opposite requirements about the well-formedness. Thus, **a grammar consists of constraints and techniques resolving their conflicts** (ibid). The constraint set is universal and all conflicting constraints are operative in individual languages. In this sense, a universal constraint set is seen as a part of the innate knowledge of language.

5.2.2 Generator and Evaluator

Generator (or GEN) is one of the main components in OT, called the operational component. **GEN produces a large candidate set of possible output forms for every input**, specifying the relationship between output forms and the input. GEN is a fixed part of Universal Grammar, and therefore it is universal; all the candidates generated by GEN are the same in every language (Prince & Smolensky 1993/2002). GEN applies all linguistic operations freely, optionally, and sometimes repeatedly. This property of GEN is called **freedom of analysis** (McCarthy 2002:8). Because of its universal character, GEN needs to make available candidates varied enough in order to anticipate all the differences found between languages. Even if the GEN is overgenerating, the grammar is not, because the output of GEN is evaluated and filtered by the Evaluator component (McCarthy 2007:4) (see below).

The second important component of OT is the **Evaluator** (or EVAL), which **evaluates candidates in terms of a particular ranking of constraints**, thus called constraint component. EVAL selects a member of the set of candidate output forms to be the actual output of the grammar. EVAL receives the candidate set from GEN, evaluates it using a constraint hierarchy, and selects the most harmonic member of the candidates as the output of the grammar. **EVAL therefore establishes an order for the candidates according to their relative harmony**. As Prince and Smolensky (1993/2002:16) originally defined it, "Harmony is a well-formedness scale along which a maximal-Harmony structure is well-formed and all other structures are ill-formed". In these terms, well-formedness is not relative, but the Harmony is (ibid.).

Originally, Prince and Smolensky (1993/2002:5) talked about H-EVAL, because EVAL determines the relative Harmony of the candidates (H-EVAL = Harmony Evaluator). The authors also mention that the explanatory load in OT is on the theory of well-formedness (i.e. EVAL), although GEN as an operational component makes its own part of the work (ibid.). EVAL is universal, because it is composed of universal constraints, as Prince and Smolensky underline (1993/2002:5). The authors (ibid.) also declare that it is necessary to be able to construct EVAL with notions of generality first with respect to Universal Grammar and thus crosslinguistically, and secondly with respect to a particular language.

In theory, EVAL might choose two candidates as the original output, because they both satisfy all the constraints equally well. However, in practice, the universal constraint set is varied

enough, that EVAL is able to identify a unique optimal output (McCarthy 2002:7). As McCarthy (2008:19) clarifies, EVAL will first work with the high-ranked constraint CONST1, and will then extract the subset of candidates that is most favored by CONST1. This subset of candidates is then evaluated according to its capability to satisfy the next constraint in the ranking system, CONST2. This procedure continues until there is only one candidate left, the optimal one.

Prince and Smolensky (1993/2002) differentiate two different conceptions of GEN. The OT model relies more on the **parallel-processing conception of GEN**: all possible outputs are considered at the same time, and importance is only placed on the structures that are allowed (Prince & Smolensky 1993/2002:86). The other concept is closer to standard generative theory and is based on serial or derivational processing, because there are some operations that GEN will perform one by one. McCarthy (2002) further explains the functioning of serial processing, where GEN generates a candidate set for an input *in*, which is evaluated by EVAL. The most harmonic member of this candidate may not be the ultimate output, because it is returned to GEN. GEN then processes it as a new input. This GEN-EVAL loop is repeated until *convergence*, i.e. until the output of EVAL after one GEN-EVAL loop is "identical to the output of the immediately preceding pass" (McCarthy 2002:159). According to McCarthy (ibid.), this model of OT is global, and it was first called *harmonic serialism* (see Prince & Smolensky 1993/2002:5-6, 86-87), which is a theory of OT variants not included in the standard version of OT. The parallel processing in OT is considered superior to the serial version (McCarthy 2002:162).

5.2.3 Constraints

Constraints are the third major component of OT. **Constraints are essentially universal** and of very general formulation as they are a product of Universal Grammar. **All constraints are violable and they easily have contradictory requirements about the well-formedness of analyses**. This means that in a conflicting situation, one constraint wins and another constraint may be violated. An individual grammar consists of a ranking of the constraints; the ranking resolves any conflict in favor of the higher-ranked constraint. According to Prince and Smolensky (1993/2002:6), **language differences are due to the different rankings of constraints**. This is because both GEN and CON (universal set of constraints) are universal.

OT predicts that all constraints are **violable**. Ungrammaticality cannot thus be the consequence of constraints, but rather it is the consequence of the inferiority of a candidate in relation to another candidate (McCarthy 2002:76). An **absolutely ill-formed structure** is such that when it is analyzed by the grammar, it occurs in no input which will lead to the output form including this structure (Prince & Smolensky 1993/2002:192). A constraint always claims its choice for the best output, even if it is low-ranked in the system. Every constraint evaluates all the candidates,

but all the constraints are not visibly active; i.e. they are so low-ranked that their influence is not seen (McCarthy 2008:11-12).

Constraints assign violation marks to candidates; no violation mark is given if a candidate does not violate the constraint. If the constraint is violated, violation marks are assigned according to how many times the constraint is violated by a candidate. CON consists of two types of constraints: 1) Faithfulness constraints and 2) Markedness constraints. They are discussed in more detail below.

5.2.3.1 Faithfulness constraints

Faithfulness constraints are inherently conservative; **they require that the output of the grammar is identical or faithful to its input**. McCarthy (2008:13) posits that faithfulness constraints are a very knowledgeable idea in OT that no other theory has used before. An example of a faithfulness constraint is an anti-deletion constraint called MAX, which demands that all the segments of the input are also present in the output. Another example is DEP, which demands all the segments of output to have correspondents in the input. MAX therefore forbids deletion, while DEP forbids insertion.

Prince and Smolensky (1993) originally talked about PARSE and FILL constraints, instead of MAX and DEP. According to Prince and Smolensky (1993:24-25), the PARSE constraint family verifies that the input segment or any other node has a correspondent in the output, and FILL demands that syllable positions are filled with segmental material. McCarthy summarizes (2002:174) that according to the PARSE/FILL constraints, deleted segments are still present in the output while being unparsed, and the syllabic positions of epenthetic segments are present in the output, although they themselves are not present. This is because the properties of the input are structurally included in the output.

McCarthy and Prince (1995) reformulated Prince and Smolensky's idea of PARSE/FILL constraints and introduced the MAX and DEP constraint families in their Correspondence theory. A MAX-IO constraint says that every segment of the input has a correspondent in the output (ibid.:17), in other words the input is *max*imally represented in the output. MAX is a reformulation of PARSE. McCarthy and Prince (ibid.) demonstrate that the MAX constraint family liberates PARSE from "its connection with syllabification and phonetic interpretation". DEP, on the other hand, demands that every segment of the output has a correspondent in the input. Therefore the output *dep*ends upon the input, hence 'DEP'. DEP resembles the function of FILL. DEP and MAX have largely replaced PARSE and FILL in the literature, as it was problematic to apply them to all phonological generalizations, as McCarthy comments (2002:13).

The third important family of **faithfulness constraints deals with featural identity**, IDENT(F), which requires that segments be featurally identical. It was originally proposed by McCarthy and Prince (1995). For example, /kaasa/ → [kaaza] violates IDENT(Voice), because the /s/ becomes voiced [z]. If many featural constraints are dominated by other constraints, it leads to phonological alternation (ibid.:17).

5.2.3.2 Markedness constraints

Markedness constraints are constraints on output forms, and they are similar to the surface-structure constraints of filters in earlier theories. Markedness constraints favor some linguistic structures over others. For this reason they are often in tension with faithfulness constraints. Some typical markedness constraints deal with syllable structures, for example the ONSET requires a syllable to have an onset, and NOCODA inhibits syllables from ending with a coda consonant. A markedness constraint assigns a violation mark to a candidate if the candidate's output structure is in violation of the constraint. The similarity of the output in relation to the input is not a relevant issue in the case of markedness constraints.

Markedness can be understood in different ways, as McCarthy (2002:15) points out. Markedness in OT is multidimensional, because different constraints like or dislike different characteristics. In consequence, markedness constraints often have conflicting demands about the optimal output. In Generative Grammar, however, "marked" was seen as something that is not expected or not very common or natural (e.g. Chomsky and Halle 1968). As de Lacy (2007:23) mentions, in OT the feature or phenomenon A is not marked because of its representational deficiency, but because constraints favoring features B are lower-ranked than those which prefer feature A. This is because markedness is settled by rankings of constraints in OT. Thus, for example, coronal sounds are less marked, because constraints that favor dorsals and labials over coronals are lower-ranked than constraint favoring coronals over other segments (id.). In OT, the markedness constraints that are low-ranked and often violated may still have an effect on the output. This is called *the emergence of the unmarked* (TETU).

Prince and Smolensky (1993/2002:72) refer to **relative well-formedness as a synonym with markedness**. The authors further explain that a feature or a phenomenon, for example tongue-height, does not bring Harmony out by itself as such, but the well-formedness issue will arise if tongue-height is evaluated in the context of ATR-harmony, for instance, because in the case of ATR-harmony the height of the vowel is a significant issue for well-formedness (see chapter 4.1.2 and 5.3.2.3 for ATR-harmony).

5.2.4 Constraint conflict and domination hierarchy

Constraints are in conflict because of the contradictory requirements they have about how to satisfy well-formedness. For example, a well-formedness constraint may require that all words will end in a vowel, but another constraint demands faithful correspondence between input and output. If the input ends in a final consonant, one or other constraint will be violated. If the faithfulness is respected, the markedness constraint about final vowels is violated; or if the markedness constraint is satisfied, the faithfulness constraint will be violated.

The central idea of OT is a technique that will determine the exact analysis of an input that best satisfies a set of conflicting conditions. In other words, an output is the optimal one (or most harmonic, see 5.2.5 below), and thus grammatically well-formed, if it violates least the constraints. In the case of most inputs, all the possible analyses violate many constraints. The grammar in question rates these analyses depending on how well they satisfy the complete set of constraints. Determining the optimal output among different output forms is dependent on the **constraints hierarchy**. **A constraint that is more dominant has an absolute priority over the constraints lower in the hierarchy** (priority-ranking). This is called a *strict dominance hierarchy* (Prince & Smolensky 1993/2002:2).

Individual grammars are constructed of the well-formedness constraints, but languages differ because these well-formedness constraints are not prioritized in the same way in all languages; i.e. the rankings of universal constraints to domination hierarchies are different in individual languages (Prince & Smolensky 1993/2002:2-3). In other words, languages resolve the conflicts among universal constraints in different ways. If one constraint dominates another, it means that these constraints disagree on the status of a pair of candidates, and therefore the dominating, or better ranked, constraint makes the decision about the most optimal output (ibid.: 18). For example, if the ONSET constraint is high ranked in two hypothetical languages, a language may have an output [wake] for the phonological word /ake/ by epenthesis (DEP constraint is violated, whereas ONSET is satisfied). Another language may solve the satisfaction of the ONSET constraint by deletion (MAX constraint is violated), having the output form [ke] for /ake/. The constraint hierarchy for MAX and DEP thus varies in these two languages. If candidates satisfy or violate a constraint equally well, then the dominating constraint does not decide between the candidates, but the comparison is passed to the lower-ranking constraint in the domination hierarchy.

5.2.5 Harmony

The concept of *Harmony* in OT comes from connectionism, although OT is not a connectivist model (Prince & Smolensky 1993/2002:3, 217-218). A simplified definition state that

Connectionism studies human cognition by employing mathematical methods, such as neural networks. The weighted connections in the neural networks engender learning and lead to cognition (e.g. Bechtel & Abrahamson 1991). According to the *Harmony maximization* (Prince & Smolensky 1993/2002:3, 220, as called by Smolensky 1986), a network acquires its information from constraints which act in conflicting and violable relation; they function in parallel in order to determine the consistency between constraints on a given input by statistical analysis. The *Harmony* of the analysis, therefore, means how well an analysis of an input satisfies a series of conflicting constraints. Consequently, as Prince and Smolensky formulate it, "a grammar is precisely a means of determining which of a pair of structural descriptions is more *harmonic*" (1993/2002:3). Comparison of candidates in pairs permits us to see a harmonic order on the whole set of alternative analysis. The optimal output is the most harmonic. Therefore, a structural description is only considered well-formed if the grammar determines it as the optimal analysis.

Candidates are analyzed in parallel, but evaluation proceeds by constraints. Parallel analysis has two dimensions which need to be considered and whose interaction needs to be controlled, as Prince and Smolensky (1993/2002:21-22) underline. First, constraints are normally applied to several substructures of candidates and therefore they create a set of evaluation. This is easily seen, for example, by the ONSET constraint, which requires every syllable to have an onset, and which evaluates all the syllables of the candidate, as the candidates very often have several syllables. Secondly, grammar altogether has several constraints, which create multiple sets of evaluations.

Harmonic Ordering of Forms, as Prince and Smolensky (1993/2002:21-22) define it, explains how to compare each set of candidates by one constraint, and how to combine the evaluation of different constraints. These two factors are needed in order to have a general and clear enough picture of the facts that characterize the comparison of the well-formedness (i.e. the harmony) of the candidates.

The standard OT requires all the constraints to be ranked. A grammar can be defined as a specific ranking of the constraints (e.g. McCarthy 2002). In the case of **variation**, some additional developments of standard OT are needed, for example to account for the fact that there may be optional pronunciations of a phoneme or a morpheme. These theoretical developments include Stochastic Optimality Theory (e.g. Boersma & Hayes 2001), which is not further discussed in this study, and the theory of Partially Ordered Grammars (Anttila 1997, 2002 & 2007).

In Partially Ordered Grammars, a grammar is defined as a partial order of a specific constraint set. A set of constraints may have a universal or fixed ranking, and another set of constraints may consist of constraints that are unranked among themselves (Anttila 2002). For example, there are three constraints A, B and C, of which the constraint A dominates both B and C, but

the domination hierarchy between A and B, and B and C varies. Thus, we have two subgrammars. The first one is A » B (meaning A dominates B) and A » C, and the second one A » B and B » C. These subgrammars may be divided into further subgrammars, where the ranking relationship of each constraint is determined. Anttila (2007:526-527) gives an example of Finnish, where the partitive form of nouns creates vowel sequences, like in words /suome-a/ (*Finnish-partitive*) and /ruotsi-a/ (*Swedish-partitive*). In different dialects, the vowel sequences are a target for vowel coalescence, i.e. /ea/ may be pronounced [ee] and /ia/ as [ii]. The /ea/ coalescence is reported to be more frequent than coalescence of /ia/. Anttila (id.) gives three constraints: FAITH (no coalescence), *EA (avoid /ea/ hiatus) and *IA (avoid /ia/ hiatus). If the ranking hierarchy is FAITH » *EA » *IA, both forms /suomea/ and /ruotsia/ are pronounced faithfully. If the ranking is *EA » FAITH » *IA, /suomea/ is pronounced [suomee], whereas /ruotsia/ is realized faithful. If the hierarchy is *EA » *IA » FAITH, the coalescence occurs in the case of both /ea/ and /ia/. These are totally ranked grammars. A partial order in this case is, for example, *EA » *IA which does not determine the ranking of FAITH.

Variation in a grammar emerges if the grammar does not clearly determine the output, i.e. the constraints do not have a fixed ranking. According to Anttila (1997), if all the tableaux select a unique winner, the phenomenon is categorical. However, the case of variation arises, if partial orders are not able to select a single winner, but they mark the output statistically, i.e. the more frequent output representation is the winner. A detailed study of variation demands considerable effort in order to be capable of comparing the phenomenon statistically in a large corpus, as Anttila (2007) states.

5.2.6 Factorial typology and the Richness of the Base

OT provides a framework for language typology. In OT, Universal Grammar is considered to supply a set of universal violable constraints, of which individual grammars make their own ranking hierarchies. As Prince and Smolensky (1993/2002:92) state, **all the possible rankings of constraints determine the typology of possible languages, because every permutation of CON (constraint set) is a possible language**. This phenomenon that grammars are being predicted by CON is called *factorial typology*. Factorial typology does not, however, predict that all possible grammars are actual languages, as McCarthy mentions (2008:235), but "every analysis of a phenomenon in one language is necessarily a theory of that phenomenon in all languages", as Prince and Smolensky (2003:215) state it. The consequence of factorial typology in OT analysis according to McCarthy (2002:12, 2008:236) is that all the proposed analyses of a particular language with new constraints should be checked for cross-linguistic consequences. New constraints should prove a plausible typology if they are to be considered a valid argument.

Prince and Smolensky (1993/2002) illustrate factorial typology by Jakobson's typology on the basic syllable structure. The Jakobson syllable typology, as cited by Clements and Keyser (1983:29) states that languages may lack syllables with initial vowels or they may lack syllable final consonants, but there are no languages which lack syllable initial consonants and syllable final vowels; that is, the CV-structure is found in all languages. In other words, there is a choice over whether onsets are required and whether codas are permitted. In OT terms, these syllable structure principles can be stated by four constraints: two faithfulness constraints and two markedness constraints. The markedness constraints are ONSET (ONS) and *CODA: ONS requires a syllable to have an onset, and *CODA prohibits a syllable from having a coda. Faithfulness constraints were originally PARSE and FILL according to Prince and Smolensky (1993/2002), but could be stated by MAX and DEP as seen in 5.2.3.1. The Jakobson typology of syllables also determines the factorial typology in OT terms; different rankings of the four constraints will result in languages' syllable structure typology. This is illustrated in (78), where the faithfulness constraints are grouped together, denoted by 'F'. The domination hierarchy is denoted by '»', i.e. F » ONS means that FAITHFULNESS dominates the ONSET constraint.

(78) Syllable structure typology (modified from Prince & Smolensky 1993/2002:93-95)

		Onsets	
		Required ONS » F	*Not required* F » ONS
Codas	*Forbidden* *CODA » F	**CV** ONS, *CODA » F	**(C)V** *CODA » F » ONS
	Allowed F » *CODA	**CV(C)** ONS » F » *CODA	**(C)V(C)** F » ONS, *CODA

In the same way that OT predicts language typology, OT also has a universal approach to language. According to the **Richness of the Base** (ROTB) –principle (Prince & Smolensky 1993/2002:209), all inputs are potential inputs for all languages. As McCarthy (2002) clarifies, ROTB predicts that there are no language-specific restrictions on the input, but the generalizations about the possible surface structures are the product of faithfulness and markedness constraint hierarchies, as they control the mappings between inputs and outputs. However, ROTB does not necessarily deny the possibility of universal restrictions in input (McCarthy 2002:73). One of the central ideas of OT is that languages differ only in their constraint ranking. In that sense, ROTB is a logical consequence of OT.

5.2.7 Conspiracy in OT

A conspiracy situation includes several phonological processes (see also 5.1). Some of these processes block and some of them trigger a phenomenon in order to respect the well-formedness conditions of a language. Linear phonology had problems in explaining conspiracy. In OT, the faithfulness constraint hierarchy can account for several processes, which all function in order to create a well-formed output in a system (McCarthy 2002:100). McCarthy (id.) posits that if a markedness constraint M1 dominates a faithfulness constraint F1, and another markedness constraint M2 dominates another faithfulness constraint F2, and if M1 is also in conflict with M2 and dominates it, then M1 is able to trigger a process while blocking another. This is illustrated below.

According to McCarthy (2002:100-101, also McCarthy 2008:9-11, 22-24), the original conspiracy problem in Yawelmani Yokuts, introduced by Kisseberth (1970), may be controlled in OT by a markedness constraint on syllable structure, which prohibits triconsonantal clusters. This is the M1, e.g. the *COMPLEX-SYLLABLES constraint prohibits CCC structures. This markedness constraint is higher-ranked than the faithfulness constraint DEP (F1); the result is that epenthesis is possible. This same markedness constraint also dominates another markedness constraint which controls vowel deletion (M2, e.g. *V# which requires that words do not end in a vowel), and thus the first markedness constraint can block the deletion. The second faithfulness constraint is MAX (see more detailed analysis of Yawelmani e.g. in McCarthy 2008:22-24, 62-64).

Although OT is able to respond to a conspiracy situation, phonological opacity is a challenge for OT. A **phonological opacity** situation is such that a general process fails to occur in some specific cases, although the conditions where the process normally occurs are met. An example of opacity is given by McCarthy (2002:174-175). In Sea Dayak (Austronesian, Indonesia) nasality spreads from a nasal to the following vowels, but nasal spreading will be prohibited by an oral consonant, although the latter does not surface. Thus /naŋgaʔ/ will become [nãŋaʔ] and not [nãŋãʔ], because the deleted /g/ blocks the nasal spreading. Serial theories can explain this situation by ordering the rules, but OT has a problem with analysis, because of knowing which kind of constraint could block the nasal spreading, if the blocking segment is present in the input. McCarthy (2002), among others (e.g. de Lacy 2007), admits that opacity is a challenge to parallelism and thus for basic OT principles. This is because opaque situations normally have some serial characteristics to which faithfulness constraints can only respond with difficulties. Several theoretical developments of OT exist to account for the opacity situation. However, those models are beyond the scope of the present study.

5.2.8 Constraint ranking and tableaux

In OT terms, differences between languages are due to the differences in constraint ranking. These theoretical constraint ranking arguments are practically illustrated by tableaux (79), where two or several outputs are compared to the same input in order to justify the ranking. Constraints are marked at the top line of the tableau in domination order from left to right. Candidates are in the leftmost column, with the original input at the top. Pointing hand symbol, ☞, helps to locate the optimal candidate, normally put on the first row of the candidates; it is called the winner. Constraint violations are marked with an asterisk, *, and a blank cell indicates that the candidate did not violate the constraint of that column. Exclamation mark, !, indicates a fatal failure of a candidate. Shaded cells illustrate that the cells do not participate in the decision; the evaluation of the candidate at hand is already determined by another higher-ranked constraint that the candidate violates. If the lines between columns are drawn by dash lines, it means that these constraints are equally ranked.

(79) Violation tableau

/kle/	MAX	DEP	*COMPLEX
i.☞ [kle]			*
ii. [ke]	*!		
iii. [kile]		*!	

In (79), [kle] wins, because it violates only the *COMPLEX constraint, which forbids clusters of two or several consonants. *COMPLEX is low-ranked, and thus dominated by other constraints. The candidates [ke] and [kile] both violate the faithfulness constraints; [ke] violates MAX, because one segment is deleted, and [kile] violates DEP, because one segment is inserted. Domination hierarchy in this language is MAX, DEP » *Complex, i.e. DEP and MAX dominate *COMPLEX. The example does not clarify the ranking relationship between MAX and DEP, i.e. the ranking argument or a proof that one dominates another is missing. Constraints are often formulated as in (80) (as McCarthy 2008:175 indicates), which gives an example for the *COMPLEX constraint:

(80) *COMPLEX: assign a violation mark for every tautosyllabic[8] cluster.

[8] Tautosyllabic refers to sounds occurring in the same syllable.

Besides the original violation tableaux, **comparative tableaux** were further developed (Prince 2000). Comparative tableaux (81) show directly the comparison between the optimal output and one of the losers - for all the constraints used in the evaluation. Asterisks as violation marks are replaced by W for winner and by L for loser. If the constraint in question favors the optimal candidate, W is used. If the constraint favors the loser competitor, L appears in the cell.

(81) Comparative tableau

/kle/	MAX	DEP	*COMPLEX	Remarks
i. kle ~ ke	W		L	Deletion worse than complex
ii. kle ~ kile		W	L	Epenthesis worse than complex

If the optimal output violates no constraints, it **harmonically bounds** any other candidates of the same input. For example in (82), there is no possibility that [ke] would win over the constraints MAX and DEP, because it violates MAX, while [kle] does not violate any of the constraints. If the constraints were ranked in the opposite order, it would not change the situation.

(82) Harmonic bounding example

/kle/	MAX	DEP
i. ☞ [kle]		
ii. [ke]	*!	

5.3 OT in phonology

In this section some OT applications in phonology are discussed. Some specific phonological processes are examined, especially how feature assimilation and vowel harmony, coalescence, and length variation are treated in OT terms when applied to Niger-Congo languages, when OT analysis is available in these languages. In some cases, examples are given from other language families.

Downing (2009) argues that OT and its developments give a fresh perspective to complex phenomena that are found in African phonologies. The author, however, admits that there are some controversial results in OT analysis, as in older theoretical analyses, for instance when analyzing the complicated issues of tonal processes, vowel harmony, and reduplication. OT analysis of Gur languages is still scarce, consisting mainly of Cahill (2007a), Anttila and Bodomo (1996, 2000 and others from the same authors), and a Master's thesis (Melick 2012) that contains

a tonal OT analysis. Examples of these studies (especially Cahill 2007a) are cited when applicable.

5.3.1 Feature assimilation

Assimilation is a frequent phonological process that may occur as a function of different features, such as a specific place or manner of articulation or voicing. Different faithfulness and markedness constraints are analyzed as having a role in feature assimilation in OT. However, McCarthy (2008) mentions that assimilation is not thoroughly analyzed in OT terms, as there is no consensus as to what markedness constraints should be involved.

Markedness constraints on feature specifications are used, following Prince and Smolensky (1993/2002). **Local Agreement constraints** restrict certain types of sequences, for example *$NV_{[-nasal]}$, which penalizes sequences of nasal consonant followed by a nonnasalized vowel (McCarthy & Prince 1995), or *NÇ penalizing sequences of nasal consonant followed by a voiceless obstruent (Pater 1999/2004). Agreement may posit for instance that obstruent clusters should agree in voicing (as in Lombardi 1999, (6)), or according to some other feature.

Alignment constraints as well as positional constraints are also employed to treat assimilation processes. The **Alignment constraint** family demands alignment between the edges (Left/Right) of morphological and prosodic domains (McCarthy & Prince 1993). Detailed examples of alignment constraints are shown in the discussion of vowel harmony (see 5.3.2). **Positional constraints**, on the other hand, can account for both faithfulness and markedness. The main idea of positional constraint is that a feature or a phenomenon is restricted to occur (or not to occur) in a specific position, which is often a prominent position such as stressed or initial syllable. Beckman (1998/2004) argues that phonological processes that are triggered or blocked in initial positions are a result of positional faithfulness constraint IDENT-σ_1(F) which is high-ranked in the system. That constraint requires a faithful input-output correspondence of a feature in the initial syllable.

Lombardi (1999) argues that positional faithfulness interacts with markedness, for example, in voicing assimilation in obstruent clusters. The markedness constraint AGREE is needed to penalize clusters that do not agree in voicing. The author uses also *LAR, following Prince and Smolensky (1993/2002), that penalizes laryngeal features, i.e. voiced consonants. Positional faithfulness constraint IDENTONSETLARYNGEAL (IDONS) requires faithfulness of laryngeal feature in Onset position. In Polish, IDONS dominates IDENTLAR, demanding that consonants should be faithful to underlying laryngeal specification, and thus the onset consonant keeps its voicing specification as in (83). Different IDENT(F) faithfulness constraints, as seen in 5.2.3.1, show how the input feature values are violated in the case of featural assimilation.

(83) Voice assimilation in Polish word /prosba/, *request* (Lombardi 1999, her (24))

/prosba/	AGREE	IDONS	*Lar	IDLAR
i.☞ [proźba]			**	*
ii. [prosba]	*!		*	
iii. [prospa]		*!		*

Place assimilation can be treated with SPREAD(place) constraint (see (84)), as employed by Padgett (1995); SPREAD does not take directionality into consideration. If SPREAD(place) dominates faithfulness constraint of a place feature, place assimilation will occur. However, there is strictly speaking no spreading in OT, as OT considers the state of inputs and outputs, not the processes. In nasal plus obstruent clusters, the obstruent often keeps its place feature. Thus $\text{IDENT}_{\text{Rel}}$ constraint is satisfied, as the consonant with [+released] feature has a faithful output correspondence, as illustrated in (85)[9].

(84) SPREAD(place): assign a violation mark for every place feature that is assigned to only one consonant.

(85) Place assimilation constraint by Padgett (1995, his (29)). 'N' denotes a non-specified place feature.

/n+gb/	$\text{IDENT}_{\text{Rel}}$	SPREAD(place)	IDENT
i.☞ ŋmgb			***
ii. Ngb		*!*	*
iii. ngb		*!**	
iv. ŋgb		*!	**
v. nd	*!**		***

Some other possibilities to account for the assimilation are also employed. Kirchner (1998, 2004) analyzes lenition by LAZY constraint, which demands minimization of articulatory effort.

5.3.2 Vowel harmony

Vowel harmony is a type of assimilation and its principles were shortly introduced in section 4.1.2. In OT, vowel harmony is described as been driven by several constraints. However, as in

[9]Padgett (1995) used FAITH instead of IDENT; the FAITH constraints refer to faithfulness constraints simultaneously including time DEP and MAX. The violation marks are reproduced faithfully to Padgett (1995, his (29)); the candidate iii. violates SPREAD three times, as there are three possible, non-occurring place-segments links.

the case of assimilation in general, different types of constraints are proposed, as Walker (2012) demonstrates. Her presentation includes four constraint types, namely Alignment, Spreading, Agree and Correspondence.

Kirchner (1993) extends **alignment constraints** to include features that need to be associated to a chosen edge of some category, as originally alignment referred to morphological or prosodic units. Alignment in vowel harmony can be restricted, for example, as in (86) for [back] feature.

(86) ALIGN-Right([back], Word): For any feature [back] associated to a segment in a word, that feature has an association to the rightmost syllable of a word (Walker 2012, her (2)).

Spread constraints are not very different from featural alignment constraints, but they do not consider category edges as alignment constraints do. However, a vowel harmony driven by SPREAD fosters harmony in both directions, rightward and leftward. Spread constraints demand a feature existing for example in the word to be linked to all segments of the word, as in (87).

(87) SPREAD([back]), Word): For all tokens of [back] in a word, if a token is linked to any segment, it is linked to all segments. (Walker 2012, her (5))

Agreement constraints, on the other hand, promote different harmony driving forces. Agreement requires a specified feature value to be identical in adjacent elements as in (88); it thus penalizes only disharmonic couplings.

(88) AGREE[F]: Adjacent segments have the same value for the feature [F]. (Bakovic 2000, his (4))

Correspondence relationship is also used as an explanation for vowel harmony; the relationship is between different elements within an output, i.e. a word, although the general concept of correspondence in OT refers to correspondence, for example, between input and output (Walker 2012).

5.3.2.1 Trigger control

Another question in vowel harmony analyses is **trigger control**, i.e. how the vowel, which is the cause for harmonization, is established. Walker (2012) gives a summary of different strategies used to solve trigger control. **Positional faithfulness constraints** are used if trigger control is found in a prominent position, such as initial syllable, root or stressed syllable. As Walker (2012) states, positional faithfulness alone is often capable of accounting for unidirectional harmony.

Stem control is another possibility for trigger control, if the stem vowel triggers the harmony in affixes. Bakovic (2000) posits that base stem and its affixed forms have a correspondence and thus they are subject to *stem-affixed (SA) form faithfulness* (see (89)). If harmony always functions from stem to affix in a language having only prefixes or suffixes, stem control is able to gain unidirectional harmony, as positional faithfulness also does.

(89) SA-IDENT(F): a segment in an affixed form [*Stem* + *affix*] must have the same value of the feature [F] as its correspondent in the stem of affixation [*Stem*]. (Bakovic 2000, his (30))

In some languages vowel harmony is *dominant-recessive*. This means that a harmonic feature engenders triggering. In the case of ATR harmony, dominant-recessive system is such that any vowel in a word which is [+ATR] will trigger harmony, and all the vowels will harmonize to [+ATR] feature (e.g. Bakovic 2000, Casali 2008). This type of vowel harmony is analyzed by **faithfulness to feature values**. This type of constraint is employed for several other features by McCarthy and Prince (1995). Bakovic (2000) uses for instance IO-IDENT[ATR] constraint which demands a faithful relation between input [ATR] value and output [ATR] value.

Sometimes **constraints prohibiting markedness** are used to analyze trigger control. Bakovic (2000:32) proposes that in dominant-recessive systems the feature value that dominates harmony is unmarked, while recessive feature is marked. In spite of several approaches, Walker (2012) postulates that other analyses of control and directionality are needed in order to explain all the attested vowel harmony patterns.

5.3.2.2 Neutral vowels

Neutral vowels include vowels that block harmony and transparent vowels that are skipped by harmony. Neutral vowels are often analyzed by featural markedness constraints, especially the blockers (Walker 2012). Some special cases of blocking are also found, such as vowels which undergo harmony but do not transmit it, as Walker (2012) reviews. This type of blocking cannot be explained by traditional featural markedness constraints.

Transparent vowels which are often analyzed as nonparticipants in harmony are more complicated according to Walker's (id.) analysis. An example of the treatment of transparent vowels is the *SKIP(σ) constraint which penalizes spreading by skipping syllables (Walker 2012, citing Uffmann 2004), as transparency is often a nonlocal phenomenon. However, it is not yet clear, whether transparent vowels actively participate in harmony, or how they do it (Walker 2012).

5.3.2.3 ATR harmony

ATR harmony may be categorized into two different types based on the assimilatory principles, and Casali (2008) also initially makes this distinction. In *root-controlled* ATR harmony, [ATR] values of the root never change, and affixes undergo harmony. These systems are considered to have a symmetrical harmony. In *dominant-recessive* harmony, the feature value that spreads is called active or dominant, and the opposite value that undergoes assimilation is called inert or recessive. [+ATR] is more often a dominant feature, but not in all cases. Dominant affixes do not harmonize, but they stay [+ATR], regardless of the [ATR] value in the root they are attached to. If a root has [-ATR] value, the dominant [+ATR] affix causes root vowels to harmonize to [+ATR] feature. Casali (id.) mentions that in dominant-recessive ATR harmony languages, some affixes are dominant; some are recessive as they assimilate to the [ATR] value of the root.

Casali (2008) further argues that some root-controlled languages, having the so-called symmetric affix harmony, may have a type of assimilation where [-ATR] undergoes harmony to [+ATR] value. In other words, it is not only the affix [ATR] value that harmonizes to the root [ATR] value. Moreover, nine-vowel languages, having the ATR opposition between high tense and lax vowels, more often have [+ATR] dominance, whereas [-ATR] dominance is more frequent in languages with a seven-vowel system (ibid.). Casali (2008) thus does not agree with the general point of view that some ATR systems are morphologically symmetric and featurally asymmetric (dominant-recessive systems), or vice versa (root-controlled systems), but rather that the [ATR] dominance is the more determining factor in ATR vowel harmony, which as a whole can be very complex. The author concludes that there is a need for more descriptive data of different languages and for more detailed theoretical considerations in this issue.

As an example of ATR vowel harmony, an OT analysis of Kɔnni is given below according to Cahill (2007a). Kɔnni (Gur, Ghana) has a stem-controlled ATR harmony including nine vowels: /i, e, u, o/ are [+ATR] vowels and /ɪ, ɔ, ɛ, ʊ, a/ are [-ATR] vowels. In his analysis of Kɔnni ATR harmony, Cahill (id.) considers ATR as a monovalent feature, because only the [+ATR] value functions actively in spreading; for that reason Cahill prefers ATR and non-ATR for [+ATR] and [-ATR], respectively. In Kɔnni, /a/ is not a neutral vowel as in many other ATR harmony languages, but /a/ alternates in suffixes with [+ATR] vowels /e/ and /o/, as shown in (90).

(90) Vowel harmony in suffixes in Kɔnni (Cahill 2007a:185).

[+ATR]		[-ATR]	
tígí-rí	*the house*	kʊ̀ʊ̀-rí	*the hoe*
sìè-kú	*the path*	nɪ̀ɪ̀-kú	*the rain*
tú-ò	*beans (sp.)*	nú-à	*mouths*
dùn-é	*knees*	tàn-á	*stones*

In Kɔnni, suffixes harmonize with the root [ATR] value. In noun-adjective words or other compound words, both [ATR] values may be present, e.g. noun is [+ATR] and adjective is [-ATR]. However, if [+ATR] adjective follows a [-ATR] noun stem, the last vowel of the noun stem harmonizes to [+ATR] feature in many cases. This is shown in (91) below where [+ATR] parts are underlined, as in Cahill (2007a:186-187).

(91) ATR patterns in compounds of Kɔnni (Cahill 2007a:186-187).

Noun-adjective

jùò-hááˈlíŋ	*new room (room-new)*
tígí-kúúŋ	*old house (house-old)*

Compound

ɲá-líírítú	*kingfisher (water remover)*
nìm-bóˈlíŋ	*lightning (rain-fire)*

Noun-Adjective (ATR spreading to leftward)

chòm-bíŋ	*small father* (chɔ̀ŋ, *father*)
bùntùù-bíŋ	*small toad* (bùntùù-kpíˈíŋ, *big toad*)

Cahill (2007a) in his OT analysis of Kɔnni ATR harmony employs different types of constraints, such as Agreement, Alignment, and featural faithfulness. A simplified sketch of his OT analysis is given here to illustrate the ATR system in Kɔnni. The Alignment constraint ALIGN[ATR]μ as in (92) is necessary to account for the fact that all the syllables of ATR morphemes will have ATR feature. It also disallows ATR spreading from the morpheme. The AGREE(ATR) constraint requires that the ATR value of a suffix is the same as the ATR value of a stem, see (93). MAX(ATR) and DEP(ATR) in (94) are featural faithfulness constraints that are needed because of the monovalent nature of ATR in Kɔnni. IDENT(ATR)$_{Lex}$ constraint demands faithfulness of ATR value in a lexical item, see (95). When ATR spreads from adjective to the last vowel of the preceding noun, ALIGN[ATR]μ constraint is violated. For that reason Cahill creates a specific *]$_{N\text{-}Adj}$[ATR constraint, as in (95), which controls ATR values in noun stems and adjectives.

(92) ALIGN[ATR]μ: ALIGN(ATR, Morpheme): any occurrence of ATR is aligned to both the left and right edges of its sponsoring morpheme. (Cahill 2007a, his (256))

(93) AGR(ATR): an affix and the stem to which it is affixed must agree in ATR (Cahill 2007a, his 261))

(94) MAX(ATR): every ATR occurrence in the input has a correspondent in the output
DEP(ATR): every ATR occurrence in the output has a correspondent in the input (Cahill 2007a, his 255))

(95) IDENT(ATR)$_{Lex}$: the value of ATR in the input of a lexical item is identical with its value in the output

(96) *]$_{N\text{-}Adj}$[ATR: a noun stem which has no ATR associations is prohibited adjacent to an ATR adjective (Cahill 2007a:199, his (268))

Examples are shown below to illustrate first the stem-controlled ATR between stem and suffix in (97). Then the basic case of compounds is considered in (98), followed by the specific case of noun-adjective constructions, when the adjective is non-ATR and the noun is ATR (in (99)).

(97) Constraints for **sie-ku**, *the path* (Cahill 2007a, his (262))

sIE-kU ATR	MAX(ATR)	DEP(ATR)	AGR(ATR)	ALIGN[ATR]μ
i. ☞ sie-ku				*
ii. sie-kʊ			*!	
iii. sɪa-ku			*!	*
iv. sɪa-kʊ	*!			

(98) Constraints for **jùò-hǎálíŋ**, *new room* (Cahill 2007a, his 265))

juo-haalɪŋ ATR	MAX(ATR)	DEP(ATR)	IDENT(ATR)$_{LEX}$	ALIGN[ATR]μ
i. ☞ juo-haalɪŋ				
ii. juo-heeliŋ			*!	**
iii. jʊa -haalɪŋ	*!		*	

(99) Constraints for bʊ̀ntùù-bíŋ, *small toad* (Cahill 2007a, his (270))

bUntUU-bIŋ ATR	MAX(ATR)	*]$_{N\text{-}Adj}$[ATR	IDENT(ATR)$_{LEX}$	ALIGN[ATR]μ
i. ☞ bʊntuu-biŋ			*	*
ii. bʊntʊʊ-biŋ		*!		
iii. buntuu-biŋ			*	**!
iv. bʊntʊʊ-bɪŋ	*!		*	

In Kɔnni, MAX(ATR) is undominated; the existing ATR feature cannot be deleted. Both IDENT(ATR)$_{Lex}$ and AGR(ATR) dominate ALIGN[ATR]μ. ALIGN[ATR]μ is violated, when ATR spreads from the stem to the suffix, and also when the ATR spreads to the last vowel of the stem in noun-adjective compounds. *]$_{N\text{-}Adj}$[ATR on the other hand dominates IDENT(ATR)$_{Lex}$, as seen in the case of noun-adjective compounds where adjective is ATR and the stem non-ATR.

5.3.3 Coalescence

Fusion or coalescence occurs when two segments fuse into one segment, which is different from the original segments but shares some features with them. Coalescence in general provokes violation of featural identity, as two segments merge to one, and only some of the features initially present are preserved in the fused element. Coalescence is often treated in OT by Correspondence Theory principles, which is a development of standard OT.

The **UNIFORMITY** constraint is a specific faithfulness constraint. Originally used by McCarthy and Prince (1995), UNIFORMITY as in (100) requires a correspondence between strings (S) of input and output and inhibits two elements of S_1 from merging in S_2.

(100) UNIFORMITY (no coalescence): no element of S_2 has multiple correspondents in S_1 (McCarthy & Prince 1995:123).

The Linearity constraint is also used in coalescence analysis. Following McCarthy and Prince (1995), Pater (1999/2004) considers LINEARITY necessary in coalescence, because the linear order of features may be disturbed in fused forms (101).

(101) LINEARITY: S_1 reflects the precedence structure of S_2, and vice versa. (Pater 1999/2004, his (5))

Vowel coalescence is one of the strategies by which languages avoid vowel hiatus, i.e. the sequence of two vowels across word boundaries. Casali (1996) presents different types of coalescence systems which also occur in Niger-Congo languages. In his OT analysis of coalescence, the author uses the SEGMENT-INTERGRITY constraint, as in (102), instead of UNIFORMITY, although it corresponds basically to UNIFORMITY.

(102) **SEGMENT INTEGRITY (SEG-INT)**: If one feature of a segment is preserved, all its features are preserved.

Many different featural faithfulness constraints also play a role in coalescence, and interestingly Casali (1996) combines several features into a constraint, such as MAX[+high] and

MAX[+ATR] features go together, because individual constraints including MAX[+high] and MAX[+ATR] are not in competition in the cases at hand[10]. Yoruba (Benue-Congo, Nigeria) has a seven vowel system with an active [-ATR] harmony. For instance, in Yoruba, sequences of /a+i/ merge to [ɛ] in the case of prefix vowel plus root vowel coalescence. According to Casali (1996), this is a typical phenomenon in seven vowel systems, whereas in nine vowel systems the fused product of the same vowel sequence is [e].

Coalescence of /a+i/ to [ɛ] as in Yoruba can be analyzed by ranking several featural faithfulness constraints above SEG-INT. MAX constraints are used in general and also in a specified form for lexical items. In the constraint hierarchy, the MAX(↓) constraint (combining [low], [-ATR] and [-high]) requires [-high] to be preserved, and it dominates $\text{MAX}(\uparrow)_{\text{lex}}$ (combining [+high] and [+ATR] in lexical item). Also MAX[-ATR], included already in MAX(↓), dominates SEG-INT and MAX(↑), and thus [-ATR] feature is kept. As $\text{MAX}(\leftrightarrow)_{\text{lex}}$ (including [front] and [round]) is ranked above MAX(↓), [low] feature is deleted. As a result, [-high] and [-ATR] values of /a/ are preserved with the front value of /i/. This phenomenon is illustrated in the following tableau, modified from Casali (1996, his (171)) for presentation purposes; the violated features are exceptionally marked in the violation cells.

(103) Yoruba /a+i/ coalescence to [ɛ] (Casali 1996, his (171))

/a+i/	$\text{MAX}(\downarrow)_{\text{lex}}$	$\text{MAX}(\leftrightarrow)_{\text{lex}}$	MAX(↓)	SEG-INT	$\text{MAX}(\uparrow)_{\text{lex}}$	MAX(↑)	MAX(↔)
i. ☞ [ɛ]			* [low]	*	* [+high]	* [+high]	
ii. [i]			*** [-high], [-ATR], [low]				
iii. [a]		* [front]			* [+high]	* [+high]	* [front]
iv. [e]			** [-ATR], [low]	*	* [+high]	* [+high]	

5.3.4 Length variation

Length variation is analyzed by different methods depending on the languages and their structures. Zoll (2004) uses positional markedness in general in the case of marked structures

[10] Casali (1996) uses PARSE instead of MAX, following the original formula of Prince and Smolensky (1993).

that have a limited distribution, i.e. the marked structure occurs in a certain position or never occurs in some other position. The author posits that positional faithfulness alone is not adequate in all cases, because it prohibits alternations only in prominent positions between input and output.

An example of positional markedness in analysis of vowel length variation comes from Kager's (1996) data of Guugu Yimidhirr (Australian, Australia), where long vowels are restricted to the first two syllables of the stem. It is assumed that the head prosodic word (Head PWd) is the prosodic unit to which syllable weight is attached. Zoll (2004) makes a modification of Kager's analysis and uses the COINCIDE(heavy syllable, Head PWd) constraint to account for positional markedness of the first two syllables (104). The faithfulness constraint IDENT(μ) is also employed to keep the vowel length identical between input and output in all contexts (105).

(104) COINCIDE(heavy syllable, Head PWd): a heavy syllable belongs to the Head PWd (Zoll 2004, her (15))

(105) IDENT(μ): Input length is preserved in the output (Zoll 2004, her (15), from Urbanczyk (1995))

Zoll (2004) illustrates how positional faithfulness alone gives incorrect predictions about vowel lengthening in Guugu Yimidhirr. Because positional faithfulness requires faithfulness between input and output in prominent positions only, it may result in marked structures (i.e. long vowels in this case) arising in weak positions. Only a positional markedness constraint, as in (104), will correctly restrict long vowels to the first two syllables of the stem.

Vowel shortening may be caused by the fact that trimoraic vowel sequences are not allowed within words. This is the case of Kɔnni, a Gur language spoken in Ghana (Cahill 2007a). In another Gur language, namely Dagaare (Bodomo & Anttila 2009), words are also required to be bimoraic, and thus an epenthetic vowel is added to a monomoraic stem CV-. This monomoraic stem may have a -CV suffix in plural with a lexically conditioned vowel lengthening, giving a structure CVV.-CV.

Cahill (2007a) analyses Kɔnni vowel shortening using the faithfulness constraints MAXMS and MAXLEX. MAXMS requires a monosegmental suffix vowel to be preserved (106), and MAXLEX penalizes deletion of a segment in a lexical item (107). The faithfulness constraints that Cahill employs were first introduced by Casali (1997), who studied vowel elision in hiatus context. Markedness constraint *VVV is also employed to prohibit trimoraic vowel sequences (108).

(106) MAXMS: every input segment which is the only segment in its morpheme must have a corresponding segment in the output

(107) MAXLEX: every input in a lexical word or morpheme must have a corresponding segment in the output.

(108) *VVV: trimoraic vowel sequences are prohibited within words

A singular word having a long vowel in the noun stem, **díí-ŋ** (*forehead*), has a plural form **dí-è**. Cahill (2007a) illustrates that in Kɔnni, the markedness constraints *VVV and MAXMS dominate MAXLEX and MAX-S (MAX-segment) as shown in (109). The plural suffix is a single vowel and it cannot be deleted, and thus the stem vowel is shortened.

(109) Vowel shortening in Kɔnni word **díè**, *foreheads* (Cahill 2007a, his (417))

dII-A	*VVV	MAXMS	MAXLEX	MAX-S
i. ☞ die			*	*
ii. de			**!	**!
iii. diie	*!			
iv. dii		*!		*

5.4 OT in tonal analysis

Tonal analysis in OT uses the same fundamental faithfulness, markedness, and alignment constraints that are employed in phonological analysis, but markedness constraints especially have some specifications that pertain solely to tone (Yip 2002). The author also mentions that there are several names and formulations for the same constraints in the literature. Here the discussion will start with an introduction to some typical constraints in tonal analysis. In the subsequent sections, some tonal processes are discussed in more detail in OT terms; these processes were already introduced in sections 4.2.4 and 4.2.5. A process of horizontal assimilation, namely spreading, and contour specifications are examined first, followed by morphophonemic tonal processes of downstep as well as dissimilation and polarization processes. Examples of those Gur languages that have OT analysis are given, when applicable.

Most of the **markedness constraints** account for the tonal well-formedness conditions that Goldsmith (1976, 1990) introduced, namely that each tone is associated to a TBU and a TBU has a tone associated with it; one-to-one association is seen as a preferable situation (see also 4.2.1). In the case of violation of these principles, some specific principles apply. For instance, if there

are more TBUs than tones, tone may spread, or in the case of more tones than TBUs, the remaining tones are to be associated to the rightmost TBU creating contour tones. Some basic markedness constraints in tonal analysis that account for tonal well-formedness conditions are *FLOAT, SPECIFY-T, NOCONTOUR and NOLONGT (Yip 2002). *FLOAT requires tones to be associated with a TBU, SPECIFY-T demands a TBU to be associated with a tone. NOCONTOUR prohibits a TBU from having an association with several tones, and NOLONGT prohibits a tone from being associated with several TBUs.

Tonal faithfulness constraints are basically the same as faithfulness constraints used in segmental phonology, namely DEP-T, MAX-T and IDENT-T. Yip (2002) also mentions the NOFUSION constraint, which penalizes separate tones from being merged. Myers (1997) prefers UNIFORMITY instead of NOFUSION; UNIFORMITY requires one-to-one correspondence between input and output tones, and thus inhibits fusion of tones. LINEARITY preserves linear order of tones.

5.4.1 Tone spreading

Tone spreading may be prohibited or restricted by different constraints. Tone spreading is prohibited by constraint *ASSOCIATE which penalizes new association lines which would associate tones to new TBUs (e.g. Yip 2002). It thus demands a faithful correspondence between input and output. The opposite constraint is *DISASSOCIATE prohibiting the removal of association lines, i.e. it penalizes tonal flop. A schematic tone spreading is illustrated in (110) according to Yip (2002). Anttila and Bodomo (1996) employ *SPREAD instead of *ASSOCIATE to prohibit tonal spreading. Cahill (2007a) further divides the *SPREAD constraint to be restricted either to high (H) or low (L) tones, *H-SPREAD and *L-SPREAD.

(110) Schematic tone spreading by Yip (2002:85)

σ σ σ | H	ALIGN-R	*ASSOC	*DISASSOC	SPECIFY
i. ☞ σ σ σ | H		*	*	**
ii. σ σ σ |/ H		**!		
iii. σ σ σ | H	**!			**

The LOCAL constraint is employed to restrict tone spreading only to the adjacent element; it penalizes tone shifting far away from its point of origin as described in 4.2.4.3 (Yip 2002). Yip (2002:84) defines it simply: "spread only to the adjacent element". Tone shifting, however, is a typical process in Bantu languages (e.g. Myers 1997, Yip 2002). In some other languages tone spreading occurs, because HLH sequences are prohibited, and tonal plateauing will occur. Cahill (2007a) creates *HLH constraint to prohibit a single L-tone association between two H-tones (see also 4.2.4.3).

Yip (2002) summarizes that unbounded spreading where tone spreads to several consequent TBUs can be analyzed by the following constraint ranking: ALIGN-R, *DISASSOCIATE » NOLONGT. Bounded spreading, on the other hand, has a ranking where LOCAL dominates: LOCAL » ALIGN-R, *DISASSOCIATE » NOLONGT. Bounded spreading is also analyzed by EXTEND(Feature Span, Left/Right) (e.g. Bickmore 1999). EXTEND requires that an input Feature Span is extended to a given direction of the output, e.g. H-tone spreading is extended rightwards.

Melick (2012) analyzes low spreading in Mbelime (Gur, Benin) with the EXTEND constraint. In Mbelime verbs, in sequences of LHH, L spreads rightward until H is associated only with the last syllable. The EXTENDL constraint demands that a low tone has to be associated with at least two syllables, see (111). This is illustrated by a construction, where a high-toned verb is preceded by a low-toned pronoun. *RISE constraint is high-ranked and it prohibits rising contours. MAXH demands faithful output of H tone. Other constraints used are ONET/μ and OCP; they are low-ranked. ONET/μ penalizes more than one tone from being associated with a single mora. Two H tones that are associated with the same syllable are realized with an upstepped H in Mbelime. Melick (id.) argues that Alignment constraints in L spreading predict wrong results, while by using EXTEND, the right candidate is chosen.

(111) EXTENDL [EXT]: The rightmost edge of each low tone must follow the rightmost edge of the first syllable with which it is associated in the output. (Melick 2012:91)

(112) L spreading in Mbelime, [ù fɛ̀ɛ̀ˈtá], *let him sweep* (Melick 2012:105).

/u feeta/ L HH	*RISE	MAXH	EXT	ONET/μ	OCP
i. ☞ u fɛɛ ta |/ /\ L H H				*	*
ii. u fɛɛ ta | | | L H H			*!		*
iii. u fɛɛ ta \/ | L H		*!			
iv. u fɛɛ ta V| | L H H	*!				*

5.4.2 Contour tones

Contour tone analysis is analyzed by markedness constraints, such as *RISE or *FALL or COINCIDE. Zoll (2003) uses COINCIDE, which limits contour distribution to certain positions, for instance COINCIDE(contour, final vowel) licenses contours to final vowel. COINCIDE is a positional markedness constraint as discussed in 5.3.4.

Contour tone restrictions are also analyzed by Alignment constraints, because of the general idea of Goldsmith's (1976) prediction that association of tones is left-to-right. The Align-Tone constraint (113) follows general Alignment constraint of Prince and Smolensky (1993). Alignment can be restricted to left or right edge of a domain. A specific ALIGN-R(Contour) constraint is also suggested; it demands all contours be word final (Yip 2002, citing Zoll 1997). If it dominates ALIGN-L, it will allow output structures with contours in final positions, although general left-to-right association is not respected.

(113) ALIGN-TONE: Align the specified edge (L/R) of a tone span with the head or edge (L/R) of a prosodic or morphological unit (Yip 2002, her (45))

5.4.3 Downstep

Downstepped tone is normally caused by a floating tone, as discussed in section 4.2.5.1., although other analyses exist (e.g. Paster & Kini 2011 and references therein). In Kɔnni (Gur Ghana), a floating high tone has the function of an associative morpheme; it was introduced according to Cahill's (2007a) analysis earlier. Cahill (2000, 2007) proposes a fundamental constraint in his analysis, namely HEAD-PROMINENCE (114). In Kɔnni, High is more prominent than Low. According to Cahill (2007a), this means that if an output has more H tones than the corresponding input, then the output is more prominent. *(H) and *(L) constraints prohibit floating tones, and *HLH penalizes HLH sequences. The example below shows how *(H) is undominated and prohibits H tone deletion. Faithfulness to H tone is equally high-ranked, as well as HEAD-PROM, which does not allow a H to be associated with the possessive pronoun.

(114) HEAD-PROMINENCE (HEAD-PROM): If a portion of a phrase is not identical with its underlying representation, the head of the phrase will increase in phonetic prominence. (Cahill 2007a, his (531))

(115) Associative noun phrase in Kɔnni **ʊ̀ zá'síŋ**, *his fish* (**zàsíŋ**, *fish*) (Cahill 2007a, his (532))

ʊ zas -ŋ | | | L H L H	*(H)	MAX(H)	HEAD-PROM	*HLH	*(L)
i. ☞ ʊ zasɪŋ | | ╲ L H L H					*
ii. ʊ zasɪŋ | | | L H L H	*!				
iii. ʊ zasɪŋ | | | L L H		*!			
iv. ʊ zasɪŋ | ╲ | | L H L H			*!	*	
v. ʊ zasɪŋ | | | ╲ L H L H				*!	

Other analyses of downstep have not been conducted with the HEAD-PROM constraint, although it is recognized that prominent positions attract high tone, and H-toned units may appeal to prominence (e.g. de Lacy 1999). In general, downstep is not often analyzed by OT; for instance Yip (2002) gives no examples of downstep. Bickmore (2000) uses the UNIFORMITY constraint,

but his downstep analysis is based on a Bantu language, where downstep is argued to be a consequence of sequence of two high tones, and not of a floating low tone. It could be possible that some Alignment constraints also could explain docking of floating tone, or docking of the high tone, as Cahill (2000) also posits by using TONE-RIGHT constraint, which requires tones to move rightward.

5.4.4 OCP and Polarization

A general principle in tonal analysis is the OCP (Obligatory contour principle), which prohibits adjacent identical elements (see 4.2.5.2). If OCP as a constraint is ranked above MAX-T, tone deletion will occur in the case of a sequence of two identical tones. This case is also called Meeussen's Rule (e.g. Myers 1997). It is illustrated by Myers (1997) in Shona (Bantu, Zimbabwe). In Shona, if H-toned copula is attached to a H-toned noun, the deletion of the second tone will occur. OCP thus dominates MAX-T and ALIGN-L.

(116) Shona OCP principle **í bángá**, *(it) is a knife* (Myers 1997, his (20))

/i banga/ | \ / H_1 H_2	OCP	MAX-T	ALIGN-L
i. ☞ i banga | H_1		*	
ii. /i banga/ | \ / H_1 H_2	*!		*
iii. /i banga/ \ / H_2		*	*!

Zoll (2003) also proposes a CLASH constraint which penalizes sequences of the prominent H tone on adjacent TBUs, such as surface structures HHL or LHH. LAPSE, on the other hand, requires that there is no non-H sequence, such as LLH or HLL. The author underlines that CLASH is not the same as OCP, because CLASH also penalizes multiple linking which OCP accepts, as shown in (117).

(117) CLASH and OCP constraint violations from Zoll (2003, her (27))

	CLASH	OCP
i.☞ bágá |/ H	*	
iii. bágá | | H H	*	*

Polarization is a dissimilatory process that may be caused by the OCP. As discussed before (section 4.2.5.2), polarization is a frequent phenomenon in Gur languages and it can be analyzed in different ways. Anttila and Bodomo (1996) posit that in Dagaare (Gur, Ghana) the OCP constraint dominates, and for that reason, for instance, a H-toned lexical root will have a low polarity suffix. The authors argue, furthermore, that in Dagaare stress plays a role beside tone, and tone functions differently whether it is lexical or derived. Polarity is thus analyzed as a stress phenomenon where penultimate stress attracts lexical tones. The final syllable receives the tone which is optimal in the context, e.g. derived polarity tone.

Cahill (2007a) on the other hand employs a specific POLAR constraint to account for the polarity of a noun class in Kɔnni. POLAR demands that in noun class 1 plural, the plural is expressed by tone which is opposite to the preceding tone. The author considers polarity as morpheme specific in that particular noun class, because in all other noun classes the suffix tends to be high, but in noun class 1 the plural suffix is opposite to the lexical tone. Cahill argues that in Kɔnni, the MAX(H) constraint is undominated and for that reason OCP constraint is not able to explain polarity phenomenon in Kɔnni[11]. In general, the OCP is not respected in Kɔnni, and thus it is not a plausible explanation for polarity. An example of polarity is given below. Depending on the word structure and lexical tone, noun class 1 in Kɔnni exhibits different constraint patterns according to Cahill (2007a). An example is given in (118), where high-toned word has a low-toned (polarity) suffix. Besides POLAR and MAX(H), also two other constraints are needed: *CONTOUR prohibiting contours, and DEP(L) demanding that a L in the output has a correspondent in the input.

[11] The order of POLAR and MAX(H) are reversed in Cahill 2004, where in (26), the case of word **jágâ** is considered (cf. the example (118) here), although this does not affect the result.

(118) Noun class 1 word **jág-â**, *shades*, (**jágín**, *shade* in singular) in Kɔnni (Cahill 2007a, his (502))

jag -a | HH ∅	POLAR	MAX(H)	*CONTOUR	DEP(L)
i. ☞ jaga | |\\ H H L			*	*
ii. jaga | | H L		*!		*
iii. jaga |／| H L		*!	*	*
iv. jaga | | H H	*!			

It can be stated, that the polarity requirement in Kɔnni is an output constraint, but the polar tone may be generated from different sources. It may be an inserted tone, an underlying tone or perhaps even a spread tone, as Cahill (2007:353) assumes. Yip (2002) considers the example of polarity in Kɔnni (citing Cahill 1999) as a good example of the advantage of an analysis that is based on output constraints.

5.5 Synthesis of the chapter

OT is a widely used theoretical framework in phonology nowadays. The phonological representations are caught by input and output levels, and the well-formedness of the output structure is dependent on the constraint hierarchy of the language. Constraints interact with each other, as they have opposite requirements on the well-formedness, and in consequence all constraints are violable. The constraints fall into two different categories, namely faithfulness and markedness constraints. The faithfulness constraints are a new insight in phonological theory, as McCarthy (2008) points out.

For a given input, the Generator (GEN) generates a set of candidates, the possible outputs. The Evaluator (EVAL) evaluates candidates and chooses the most harmonic one depending on the ranking of the constraints. **The same output configurations may be achieved by different processes in different languages**, i.e. consonant clusters may be avoided by consonant deletion or vowel epenthesis. **The constraint hierarchy**, and thus the different requirements, **between faithfulness and markedness constraints determine the processes that will be applied**. **The**

different rankings of the constraints define the typology of the possible languages. OT therefore predicts the factorial typology of languages.

OT has several advantages over the linear rule-based phonology. One of the major improvements is the parallel nature of the theory, as it has been recognized that phonological regularities are largely parallel, and not serial. As Burzio (1995:3) states, parallelism seems to be a "pervasive property of language organization". In OT analysis, the role of morphology in relation to phonological processes has also become more explicit (e.g. Downing 2009).

In general, it can be stated that OT is well suited to the analysis of both segmental and suprasegmental processes, with the many developments of the standard OT that have been established. A reason for the developments of the standard OT is the fact that the analysis of some basic and recurrent phonological processes, such as assimilation, is feasible with different families of constraints in OT (e.g. positional constraints or agreement constraints). In other words, there is no consensus about the set of constraints that should be used to analyze a specific phenomenon. For instance, the complex varieties of vowel harmonies have given new insights into optimality theoretic analysis, but the settled solutions of analysis and/or explanations are yet to be found (e.g. Walker 2012). A clear weakness of OT is the fact that it cannot treat opacity, although some developments of the standard OT have been created to account for this phonological process. It is true, however, that OT is not the only theoretical framework which encounters problems explaining opacity.

In African language research, as was mentioned earlier, OT has given new insights into the analysis of some complex phonological phenomenon, such as tone shift, reduplication, and vowel harmony (Downing 2009). However, the examination of these complicated processes has also created new expansions of standard OT, such as Optimal Domains Theory, which has been applied in the analysis of tonal phenomena in Bantu languages (e.g. Cassimjee & Kisseberth 1998). As Downing (2009) summarizes, the OT approach to these problematic phonological and tonal operations diminishes the abstractness of analyses. According to OT principles, the new analyses also demand a comparative approach because of the factorial typology that the OT analysis predicts. Downing (2009) also postulates that OT has not yet been significantly applied to the whole phonological and tonal grammars of a language. Thus, more thorough analyses of the complete language systems are still needed so that the unsolved theoretical problems can be discussed with more agreement.

OT has proved to be a powerful tool in phonological analysis and its advantages outweigh the weaknesses. The explanatory strategy relies on the constraint interaction, and thus the representational procedures are not at the center. However, some earlier theoretical developments, such as autosegmental theory in tonal analysis, can be used together with OT principles. In the subsequent sections of this study, the phonology and tonal system of Samue are

presented and analyzed by an output-based method, which also includes an overview of the acoustic features of the sound and tonal systems.

6 PHONOLOGICAL AND MORPHOPHONOLOGICAL STRUCTURE OF SAMUE

In this chapter, the phonological and morphophonological structures of Samue are examined. First, consonants phonemes and their allophones are discussed, followed by a description of the vowel system. Consonant allophones are presented with some acoustic information, although the focus of this study is not on the acoustic details, but rather the phonological system. Vowels are presented in the phonological system, and their phonetic realization is illustrated by vowel formants. In the subsequent sections, syllable structures and other phonotactic issues of Samue are examined. The chapter ends with an examination of the morphophonological processes of Samue, such as consonant assimilation and vowel harmony. All the processes and alternations are first described and then analyzed by using the Optimality Theoretic approach.

6.1 Consonant phonemes

The consonantal system of Samue includes 14 consonant phonemes: /p/, /b/, /t/, /c/, /k/, /k͡p/, /m/, /n/, /f/, /s/, /l/, /ɾ/, /j/ and /w/. In Table 4, all consonants are classified according to the place and manner of articulation, with voiceless consonants always on the left side of each cell. Phonemic analysis was done with 1800 lexemes, as described in 2.4.2, and evidence for contrasts is shown in (119) (Annex 1 shows the minimal pairs of all consonantal contrasts). Consonants can be contrasted in the initial position of monosyllabic words (both verbs and nouns) with vowel /a/, except for /ɾ/ and /l/. This is because /ɾ/ is found only in the medial position, and no simple verb begins with an /l/. The contrasts show semi-minimal pairs (see tone or nasality). The verbs are presented in their shortest form, the imperative mood, while the nouns are in the singular.

Table 4. Consonant phonemes.

	Labial		Alveolar		Palatal		Velar		Labial-velar	
Plosive	p	b	t		c		k		k͡p	
Nasal		m		n						
Fricative	f		s							
Lateral				l						
Flap				ɾ						
Approximant						j				w

(119)

	Verb	***Gloss***	**Noun**	***Gloss***
/p/	**pā**	*to come*	**pa̰a̰**	*hole*
			pàɾă	*muddy soil/ground*
/b/	**bá**	*to give, to help*	**báà**	*house, hut*
/m/	**mà**	*to beat, to hit*	**máá**	*soil*
	má	*to build*		
/f/	**fàà**	*to be numerous*	**fáɾā**	*skin*
			fa̰a̰	*sweet pea*
/t/	**tà**	*to hand*	**tàá**	*rock*
/n/	**nā**	*to hear*	**na̰a̰**	*mouth*
			náá	*frontier*
/s/	**sa̰**	*to dwell*	**sáà**	*rice field*
/l/	**là-sí**	*to peel*	**làá**	*place*
/ɾ/	**sáɾá**	*to strike*	**káɾă**	*hook*
/c/	**cá**	*to bark*	**cáá**	*rainy season*
/j/	**já**	*to ask for*	**jáá**	*year*
/k/	**kà**	*to chew*	**káà**	*baboon*
/k͡p/	**k͡pá**	*to draw (water)*	**k͡páá**	*dryness*
/w/	**wá**	*to lock up*	**wáà**	*shea (tree)*

In what follows, the characteristics of each group of consonants are presented by manner of articulation. Stops are discussed first, followed by nasals, fricatives, liquids and approximants. The allophones of consonants are presented also with acoustic comparisons by spectrograms and oscillograms, although this study does not examine all the acoustics properties of consonants in detail. Stops and fricatives belong to the group of obstruent sounds, in contrast to sonorant sounds including nasals, liquids, and approximants.

6.1.1 Stops

6.1.1.1 Data

Samue makes the phonological distinction between the following stops: /p/, /b/, /t/, /c/, /k/, /kp/. Stops have five places of articulation, namely bilabial, alveolar, palatal, velar and labial-velar. Stops are phonemically voiceless, except for /b/.

Stops have a tendency to become voiced between vowels or after a nasal element. Sometimes in that position they may also become weakened[12] to approximants. Some researches in Gur languages report consonant weakening (Naden 1989); for example in Kɔnni the lenition is from a stop to a fricative (Cahill 2007a). In Samue, however, this is not the case, but lenition is from a stop to an approximant. There is a quite large amount of free variation between speakers, and also within a speaker depending on the speaking rate or the intensity. In complex words within morpheme boundaries, the voiceless stops have a tendency to stay voiceless (see (120) where morpheme boundary is marked by a hyphen).

(120) Simple lexemes with a voiced medial stop (left side); compound words with a voiceless medial stop (right side).

Simple word			Compound word		
/lɛ̀n**t**áá/	[lɛ̀n**d**áá]	*basket*	/pā́-**t**ìé/	[pā́-**t**ìé]	*footprint (foot-spot)*
/tá**b**ìlǎ/	[tá**b**ìlǎ]	*bow*	/tà-**p**ìé/	[tà-**p**ìé]	*small rock*
/pō**c**ā-nǎ/	[pō**ɟ**ānǎ]	*small lizard*	/bā-**c**ǎ/	[bā-**c**ǎ]	*ewe (sheep-fem.)*
/káá**k**ǎ/	[káá**g**ǎ]	*tortoise*	/kà-**k**ùá/	[kà-**k**ùá]	*iron (thing-stone)*
/k͡pē**k͡p**èɛ̄-ná/	[k͡pē**g͡b**èɛ̄ná]	*rust*	/kà-**k͡p**ě/	[kà-**k͡p**ě]	*(thing-) big*

The stops are frequent in a word initial position, but they are also found in medial positions. They are not allowed in a word final position, but stem-finally they are found in verbs.

[12] The weakening does not occur in the Néguéni dialect where stops are voiceless also in intervocalic position.

The Labial stops are /p/ and /b/. /b/ is the only voiced stop having a phonemic status. It may be weakened to [β̞] in intervocalic position. The voiceless bilabial stop /p/ is not often attested in medial position in lexical stems, but rather word-medially as an onset of diminutive morpheme -**pie**. Additionally, the voiced /b/ is word-medially more frequent as an onset of plural noun suffixes -**bE** or -**ba** than in stems (see examples in (121)). The /b/ in noun suffix onsets also becomes weakened, as shown in the Figure 6.

(121)

/b/ in medial position of a stem		Diminutive -**pie**		Noun suffix -**ba** or -**be**	
lùbè-nŭ	*smell*	**lúú-píé**	*bird*	**cìì-bă**	*cricket*
lábá-já	*poor*	**kúú-píé**	*day*	**píl-bé**	*child*

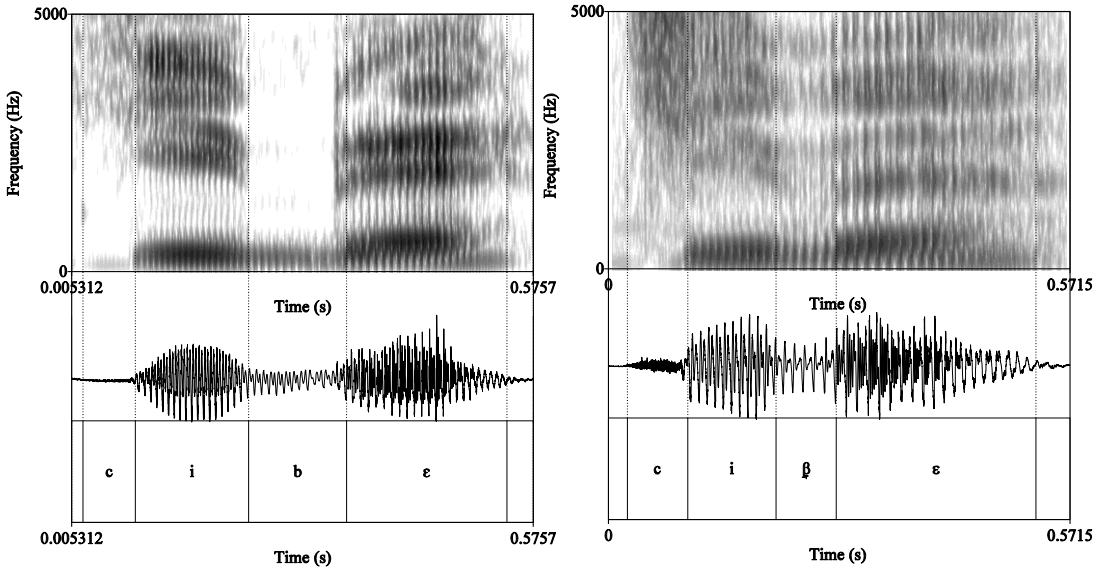


Figure 6. On the left side, /b/ is realized as [b], and on the right side as [β̞] in word /cíī-bĕ/, *woman* (different speakers).

The alveolar stop /t/ is realized as a [d] after a nasal element, vowel or consonant. This is also a case of free variation as some speakers use [t] in those same words. After a nasal element, the oral closure of [d] is very short or nearly nonexistent (see in Figure 7). The alveolar stop is rare in a medial position. **The palatal stop** /c/ also becomes voiced [ɟ] after a nasal or in intervocalic position. In Figure 8, it is already possible to see the formant transitions at the end of the first vowel /ã/ towards the palatal place of articulation.

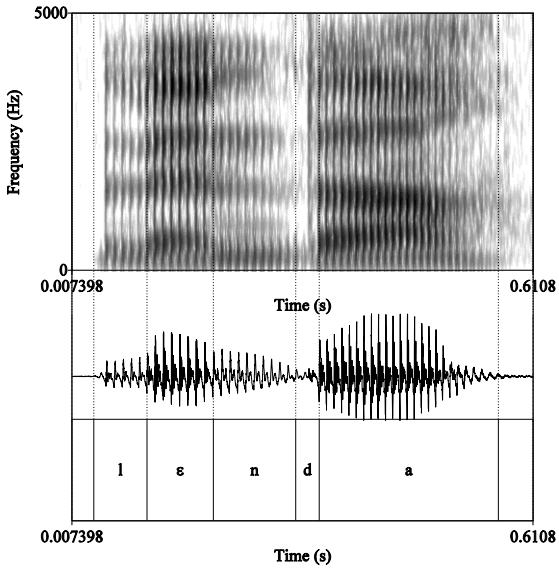


Figure 7. The word [lɛ̀ndáá], *basket*, with a short oral closure.

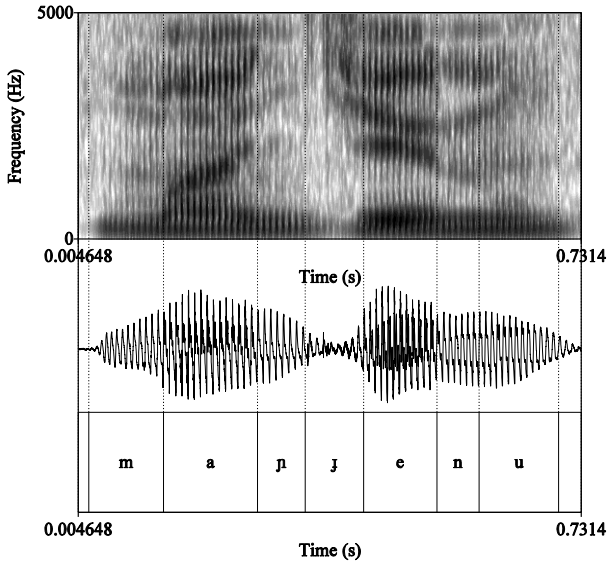


Figure 8. The word [mā̃ɲɟéénú], *papaya*, with a voiced [ɟ] in medial.

The voiceless **velar stop** /k/ has the same characteristics as the other stops in Samue. It is often realized as a voiced [g] or weakened [ɰ] in intervocalic position, especially between back vowels (see Figure 9). In morpheme edges, /k/ has a tendency to stay voiceless, as previously shown in (121). The **labial-velar stop** /kp/ becomes voiced in intervocalic positions or after a nasal. /kp/ is not allowed before /u/ in Samue. This is cross-linguistically attested, as the vowels missing after /kp/ are most often the high back round vowels (Cahill 1999:159). Naden (1989) also posits that

there is alternation that links some lexical items having /kp/ and /k/ in some Gur languages, for example, between lexemes like *kill/die*, which are **ku** vs. **kpi** in Mampruli. In Samue, the verb *die* has an imperative form **kú**, while the imperfective aspect form is **kpāā**. However, a single example shows only lexical variation.

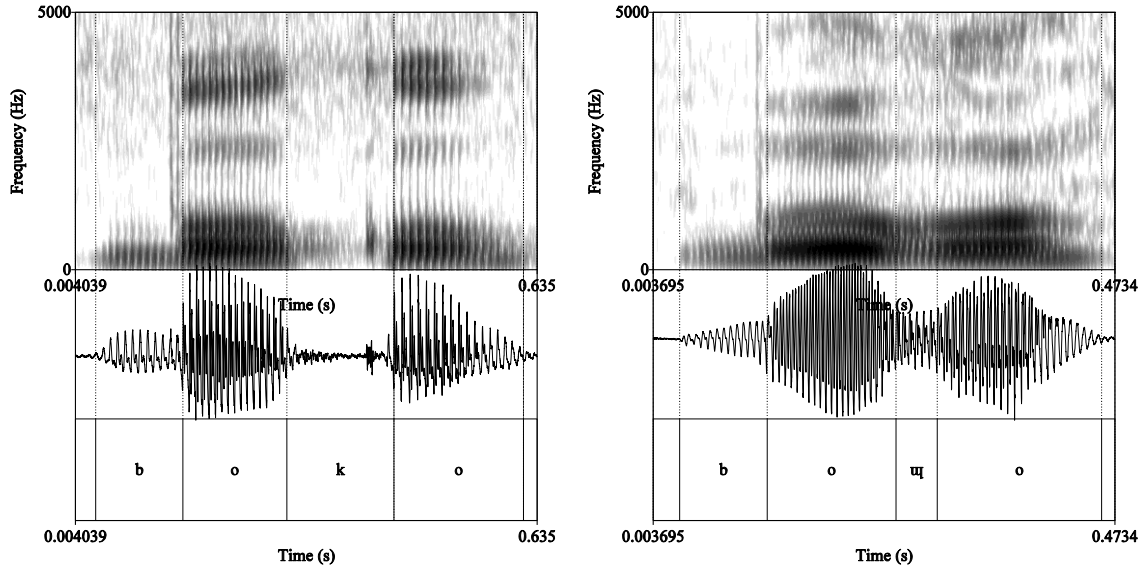


Figure 9. The word /bóókò/, *village*, pronounced [bóókò] in the left and [bóóɯ̀ò] on the right.

The glottal stop may occur in Samue in an intervocalic position, if both vowels are of the same quality (see (122)). The glottal stop does not have a phonemic status in the language. The sequence of two isotimbral vowels may be pronounced also as a long vowel.

(122)	[ì	ʔ	í	klé-mù	n̄	sāgā-ā	nā]
	3s		3s.PSS	hand-pl	pNH	wash-IPFV	AFF
	He is washing his hands.						

6.1.1.2 Analysis

As seen in the preceding section, obstruents are voiceless, except for the bilabial /b/, unless they are in intervocalic position. In that environment they are voiced or weakened to an approximant (see (123)). However, the voicing and the lenition are optional and they do not occur every time. The variation between and within speakers is quite large.

(123) Samue stop voicing or lenition

/bóókŏ/	→ [bóógŏ], [bóóɯ̆ŏ]	*village*
/káákă/	→ [káágă], [kááɯ̆ă]	*tortoise*
/mɜ̀káná/	→ [mɜ̀gáná]	*sheet*
/ḭ̀cɑ́/	→ [ḭ̀ɟɑ́]	*embers*
/lèntáá/	→ [lèndáá]	*basket*

The following constraints are needed to account for the voicing and the lenition:

(124) IDENT[voice]: assign a violation mark for every input-output pair where input and output have different values for the feature [voice]

(125) AGREE[voice]: assign a violation mark for every medial consonant which does not agree in [voice] with an adjacent segment

(126) *OBS[+voiced]: assign a violation mark for every voiced stop

(127) IDENT[cont]: assign a violation mark for every input-output pair where input and output have different values for the feature [continuant]

(128) AGREE[cont]: assign a violation mark for every medial consonant which does not agree in [continuant] with an adjacent segment

The cases of voicing and weakening need to be analyzed separately, because the ranking hierarchy is different in each case. The fact that voicing and weakening are cases of variation in Samue will be examined in more detail at the end of this section with the Partially Ordered Grammars method.

The case of voicing will be discussed first. Tableau (129) compares the unfaithful winning candidate [káágă] with the faithful candidate *[káákă], which is the loser. [káágă] violates *OBS[+voiced] and IDENT[voice], as it has a voiced stop. The losing candidate [káákă] does not violate these constraints, but it violates the higher-ranked markedness constraint AGREE[voice]. AGREE[cont] requires adjacent sounds to agree for the feature [continuant]. In [+continuant] sounds, air flows continuously through the mouth; [+continuant] consonant sounds include fricatives and approximants, and all vowels are considered as [+continuant]. The ranking argument AGREE[voice] » AGREE[cont], *OBS[+voiced], IDENT[voice] is illustrated in (129)[13].

(129) AGREE[voice] » AGREE[cont], *OBS[+voiced], IDENT[voice]

/káákă/	AGREE[voice]	AGREE[cont]	*OBS[+voiced]	IDENT[voice]
i. ☞ [káágă]		*	*	*
ii. [káákă]	*!	*		

[13] OTSoft software (Hayes, Tesar & Zuraw 2003) was used to verify the rankings illustrated in the present study

Tableau (130) illustrates the ranking argument for IDENT[cont] » AGREE[cont]. This ranking prefers a voiced obstruent over an approximant or a voiceless or a voiced fricative, although the AGREE[cont] constraint is violated. The faithfulness constraint IDENT[cont] is higher ranked, favoring the winner [káágă]. The ranking between IDENT[cont] and AGREE[voice] stays unresolved.

(130) IDENT[cont], AGREE[voice] » AGREE[cont], *OBS[+ Voiced], IDENT[voice]

/káákă/	IDENT[cont]	AGREE[voice]	AGREE[cont]	*OBS[+ Voiced]	IDENT[voice]
i. ☞ [káágă]			*	*	*
ii. [kááɰă]	*!				*
iii. [káákă]		*!	*		
iv. [kááxă]	*!	*!			
v. [kááɣă]	*!			*	*

The voicing as a lenition process is not always sufficient, however, the weakening of a stop to an approximant is often attested as well. The weakening of a stop to an approximant can be accounted for by ranking AGREE[cont] higher than IDENT[cont]. In that case the candidate [kááɰă] having the approximant will win over the candidate with [g] (see in (131)). The faithful candidate [káákă] is a loser too, because it also violates the AGREE[voice] constraint. In order to outrank a voiced fricative, the *OBS[+ voiced] constraint must dominate IDENT[voice].

(131) AGREE[cont], AGREE[voice], *OBS[+ voiced] » IDENT[voice], IDENT[cont]

/káákă/	AGREE [cont]	AGREE[voice]	*OBS[+ voiced]	IDENT[voice]	IDENT[cont]
i. ☞ [kááɰă]				*	*
ii. [kááɣă]			*!	*	*
iii. [káágă]	*!		*!	*	
iv. [kááxă]		*!			*
v. [káákă]	*!	*!			

In the case of morpheme boundaries, as in noun-adjective compounds, the morpheme initial voiceless stop stays voiceless. The preservation of the voiceless stop can be accounted by ranking the specific positional faithfulness constraint IDENT[voice]$_{mi}$ (see (132)) higher than

AGREE[voice]. Thus, the faithful candidate /kà-kùá/ wins in (133). The less specific IDENT[voice] is dominated by IDENT[voice]$_{mi}$ and AGREE[voice] when a noun-adjective compound is compared to a simple word, where the medial stop becomes voiced. This is illustrated in (133)b).

(132) IDENT[voice]$_{mi}$: assign a violation mark for every morpheme initial consonant which has a different value in [voice] between input and output

(133) IDENT[voice]$_{mi}$ » AGREE[voice] » IDENT[voice], *OBS[+voiced]

a) /kà-kùá/	IDENT[voice]$_{mi}$	AGREE[voice]	IDENT[voice]	*OBS[+Voiced]
i. ☞ [kà-kùá]		*		
ii. [kà-gùá]	*!		*	*
v. [kà-ɰùá]	*!		*	
b) /káákă/	IDENT[voice]$_{mi}$	AGREE[voice]	IDENT[voice]	*OBS[+Voiced]
i. ☞ [káágă]			*	*
ii. [káákă]		*!		

As there is variation in Samue between the realizations of phonemic voiceless stops in a medial position, the theory of Partially Ordered Grammars (Anttila 1997, 2002 & 2007) is applied, as the standard OT requires all the constraints pairs to be ordered. This was discussed previously in 5.2.5. In Samue, it is possible to state that the tendency of stops to become voiced is high in medial positions, although frequency analyses have not been conducted. Accordingly, the variant [voiced] (e.g. a voiced obstruent) can be postulated to be the most frequent in the medial position, while [approximant] is less frequent. As a consequence, a partial ordering of the constraints IDENT[cont], *OBS[vcd] and AGREE[cont] is presented below in (134); the ranking of these constraints is variable in Samue. The voicing constraints are not presented here, because the faithful voiceless outputs occur especially in morpheme boundaries, i.e. in specific positions, which was accounted for by a positional faithfulness constraint in (132). Thus, in voicing and in lenition, the AGREE[voice] constraint dominates IDENT[voice]; i.e. that ranking is not variable.

There are two possibilities of variation, namely voicing and lenition. In the case of voicing, i.e. [g], IDENT[cont] dominates AGREE[cont]. In the case of lenition, AGREE[cont] dominate IDENT[cont]. The *OBS[vcd] is dominated by the IDENT[cont] in voicing, and it dominates IDENT[cont] in lenition.

(134) **Partially Ordered Grammars**

a) **voicing**, e.g. [g] ID[cont] » AG[cont]
ID[cont] » *OBS[vcd]

b) **lenition**, e.g. [ɰ] AG[cont] » ID[cont]
*OBS[vcd] » ID[cont]

In the case of a) voicing, the partial ordering IDENT[cont] » AGREE[cont] can include total rankings such as IDENT[cont] » AGREE[cont] » *OBS[vcd] or IDENT[cont] » *OBS[vcd] » AGREE[cont], as the partial ordering does not predict the ranking of the other constraints, but only that IDENT[cont] dominates AGREE[cont]. The partial ranking in the case of Samue does not predict the ranking between AGREE[cont] and *OBS[vcd], only that IDENT[cont] must dominate AGREE[cont] in the case of voicing. If these orders are reversed, other phonological processes will emerge, i.e. the faithfulness or the lenition.

6.1.2 Nasals

The bilabial /m/ and the alveolar /n/ have phonemic status in Samue. Nasals are allowed in word-initial and medial positions, and only rarely in stem final or word final positions. Normally, this occurs in rapid speech when a second vowel of the word stem is deleted in noun-adjective complexes (see (135)). Alveolar nasal is however attested in a coda position word-internally.

(135) /túmú-ná/ *beard* [túm-làmì-ná] or [túmú-làmì-ná] *long beard*

The palatal nasal [ɲ], the velar nasal [ŋ] and the labial-velar [n͡m] occur phonetically, but they do not have a phonemic status in the language. [ɲ], [ŋ] and [n͡m] are allophones of /n/, and their distribution is restricted to nasal + stop sequences, where the alveolar nasal /n/ assimilates to the following stop by its place of articulation. The [ɲ] is found also as a result of nasal + /j/ sequences. Assimilation occurs especially in noun-adjective compounds, but also word-medially. Some examples are shown in (136) below.

(136) Phonetic [ɲ], [ŋ] and [n͡m].

Phonological form	**Pronunciation**	***Gloss***	
/mm̃áncéénú/	[mm̃**ɲɟ**éénú]	*papaya*	
/kānká/	[kā**ŋ**gá]	*molar*	
/kpɛ̄nkpâ/	[kpɛ̄**n͡m**g͡bà]	*gall bladder*	
/wűtèè-nă/		*spirit*	
/wűtèn-jě/	[wűtè**ɲ**ě]	*bad spirit*	(jesie = *to be evil*)
/kpǐ-né/		*words*	
/kpǐn-jě/	[kpǐ**ɲ**ě]	*bad words*	
/kpáà-nă/		*shelter*	
/kpáàn-kùà/	[kpâ**ŋ**gùà]	*empty shelter*	(kua = *empty*)
/bùtɛ̄-ná/		*sack*	
/bùtɛ̄n-kpě/	[bùtɛ̄**n͡m**g͡bě]	*big sack*	(kpe = *big*)

The bilabial nasal /m/ does not assimilate to the following stop if the contact is caused by an elided vowel, such as /tùmùtáá/, *errand*, which can be pronounced [tùmtáá] in rapid speech. Two nasals of different points of articulation are attested if the speech rate is rapid, if a vowel between /m/ and /n/ is deleted: [nàmnă] vs. [nàmìnă], *scorpion* (see Figure 10). A more thorough analysis of nasal assimilation, as well as other place assimilation, is given in section 6.4.1.

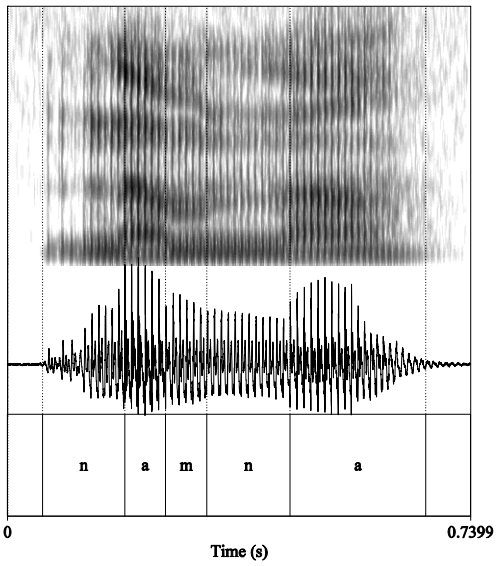


Figure 10. Word [nàmnă], *scorpion*, with [mn] sequence.

6.1.3 Fricatives

6.1.3.1 Data

Samue makes the phonological distinction between two fricatives: a labiodental /f/ and an alveolar /s/. Fricatives are part of the obstruent group, and therefore might be expected to have the same characteristics as stops, i.e. to become voiced in intervocalic position. However, /f/ in Samue is always voiceless, but at the same time it is very rare in intervocalic position. Only nine simple words are found where /f/ is attested in a medial position.

The phoneme /s/, on the other hand, has different variants as shown in (137): a voiced [z] in intervocalic position between any vowel quality and after a nasal element, a postalveolar [ʃ] in front of /ia/- or /ie/-vowel sequences, and [s] elsewhere. As in the case of stops, the /s/ can be weakened to an approximant. The alveolar approximant is represented by [z̬]. The weakening is more frequent when articulation is not careful. The voicing and the lenition of /s/ is a case of

free variation, as was already discussed with stops. The postalveolar [ʃ] can be considered as an allophone of /s/. The phonetic realization of /s/ and its variant is illustrated in Figure 11 with [s] and [ʃ], and in Figure 12 with [z] and [ʐ].

In general, fricatives in Samue are found in an initial and medial position, but they are not allowed in final positions. However, in four verb stems ending with a consonant, /s/ is attested stem-finally.

(137) Variants of /s/

/sáá/	[**s**áá]	*rice field*	/sáká/	[**s**ágá]	*to wash*
/káásá/	[káá**z**á]	*bloom*	/cììsě/	[cìì**z**ě]	*to insult*
/jírípìsě/	[jírpì**ʐ**ě]	*(small) ants*	/ǹ sí/	[ǹ**ʐ**í]	*my dad*
/síà/	[**ʃ**íà]	*big brother*	/sīé/	[**ʃ**īé]	*to do purposely*

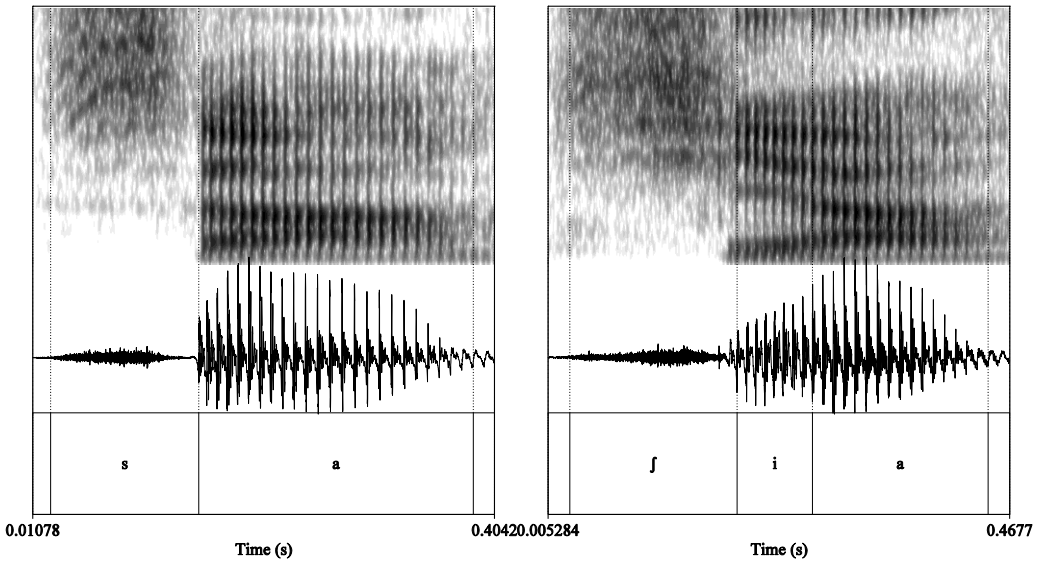


Figure 11. The fricative [s] in the left side (word sáá, *rice field*) and [ʃ] in the right side (word síà, *big brother*).

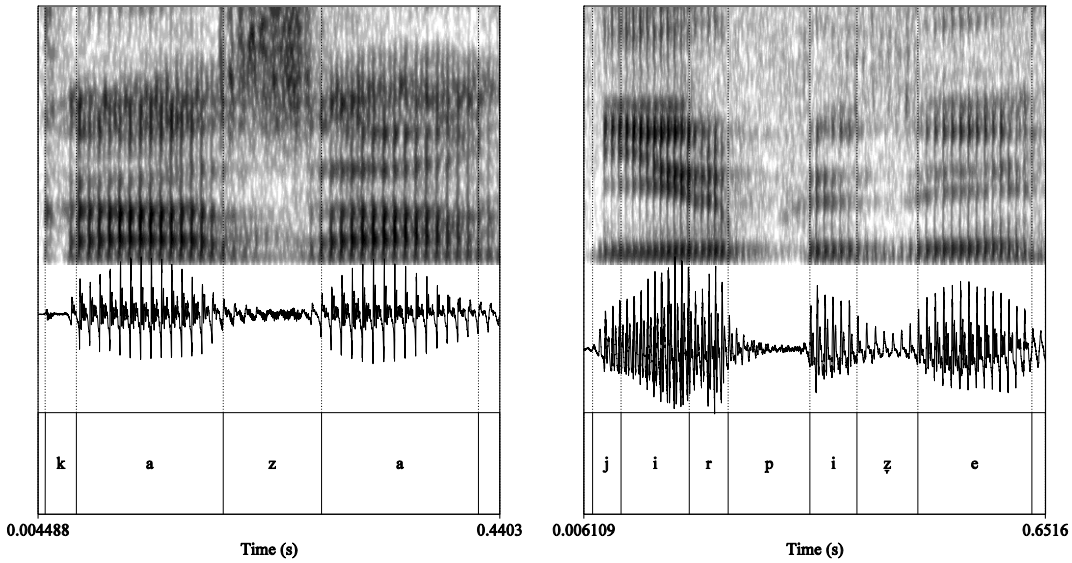


Figure 12. The fricative [z] in the left side (word káásá, *broom*) and [ẓ] in the right side (word jírpìsě, *ants*).

6.1.3.2 Analysis

As seen previously, the phoneme /s/ has four variants, which are partially in complementary distribution. The voiced [z] and the weakened variant [ẓ] occur in a medial position, intervocalic or after a nasal, the postalveolar [ʃ] precedes /ie/- or /ia/-vowel sequences, and [s] occurs elsewhere (see (137) above). However, this variation is optional, i.e. some speakers prefer [s] to [z] in intervocalic position. To account for these variants in Optimality Theoretic analysis, several constraints are needed. First, the allophonic case of palatalization is examined, followed by the free variation in the case of the voiced variants [z] and [ẓ].

Cahill (2007a) analyzes palatalization in the case of Kɔnni by a constraint which employs a feature [anterior] prohibiting a coronal fricative (i.e. alveolar) which is [+anterior] to be adjacent to front vowels, which are [-anterior]. Cahill analyzes palatalization by variable ranking of the markedness constraint and faithfulness constraint, because in Kɔnni the palatalization is optional. Rubach (2007) employs the same type of constraint, which is however named PAL-i. This requires that a consonant and a following high vowel agree in [coronal, -anterior] features. In Samue, another restriction is needed, as the palatalization occurs only when the front vowel /i/ is followed by another vowel, which is [-high]. Thus, in this study, Rubach's constraint is modified, and PAL-i-[-high] is used instead, as formulated in (138). The long /ii/ does not trigger palatalization in Samue. The faithfulness constraint IDENT[ant]$_c$ requires faithfulness of the [anterior] feature of the consonant (see (139)).

(138) PAL-i-[-high]: assign a violation mark for every coronal fricative [+anterior] which is adjacent to a front vowel [-anterior] and followed by [-high] vowel

(139) IDENT[ant]$_c$: assign a violation mark for every input-output pair where the input consonant and the output consonant have a different value for the feature [anterior].

The word /sí-à/, *big brother*, will have the output form [ʃíà], as in (140). The winning candidate [ʃíà] violates IDENT[ant]$_c$, but the faithful loser violates more dominating PAL-i-[-high] constraint. In Samue, IDENT[ant]$_c$ is dominated by PAL-i-[-high].

(140) PAL-i-[-high] » IDENT[ant]$_c$

/sí-à/	PAL-i-[-high]	IDENT[ant]$_c$
i. ☞ [ʃí-à]		*
ii. [sí-à]	*!	

The palatalization does not occur when the front vowel is long, or when the /i/ stands alone as a short vowel. This is illustrated below. In (141) and (142), the winning candidate remains faithful to the [anterior] feature of the consonant, in the case of long /ii/ as well as in the case of short /i/. However, this analysis does not prove a ranking relationship between PAL-i-[-high] and IDENT[ant]$_c$.because the winning candidate does not violate either PAL-i-[-high] or IDENT[ant]$_c$.

(141) /sìì-bě/, *trees*

/sìì-bě/	PAL-i-[-high]	IDENT[ant]$_c$
i. ☞ [sììbě]		
ii. [ʃììbě]		*!

(142) /similě/, *shirt*

/símìlě/	PAL-i-[-high]	IDENT[ant]$_c$
i. ☞ [símìlě]		
ii. [ʃímìlě]		*!

The weakening of [z] to [ẓ] in a medial position can be analyzed with constraints related to the voicing and the prohibition of the voiced stops. This is illustrated in (143) with the word /jírípìsě/, *ants*. The candidates with a voiceless fricative are out-ranked by the AGREE[voice] constraint. Accordingly, the voiced variant [z] is a loser, because the *OBS[+voiced] constraint is higher ranked than IDENT[voice]. However, the candidates iii. and iv. are not differentiated by

these three constraints. That could be done by the previous IDENT[ant]$_c$ constraint, because [ʃ] violates it but not the [s]. IDENT[ant]$_c$ would be ranked higher than IDENT[voice].

(143) */jíɾípìsě/*, *ants*

/jíɾípìsě/	AGREE[voice]	*OBS[+voiced]	IDENT[voice]
i. ☞ [jíɾpìẓě]			*
ii. [jíɾpìzě]		*!	*
iii. [jíɾpìʃě]	*!		
iv. [jíɾpìsě]	*!		

The winning candidate in (143) violates IDENT[voice] which is not high-ranked in the case of weakening. Thus, [jíɾpìẓě] wins over the faithful candidate [jíɾpìsě], and the candidate with a voiced obstruent, [jíɾpìzě]. The realization of /s/ in the medial position is a case of variation and could be analyzed with partially ordered grammars, as was discussed in the case of stops (see 6.1.1.2).

6.1.4 Liquids

The alveolar lateral /l/ and the alveolar flap /ɾ/ do have phonemic status in Samue. The distribution of /ɾ/ is limited, as it is not allowed in initial position. However, in medial position, it shows contrast with both /l/ and /n/ (see examples in (144)). In many Gur languages, [ɾ] does not have a phonemic status, but it is in complementary distribution with the phoneme /d/; /d/ is realized [d] in initial position, whereas in medial position it is realized as [ɾ] (e.g. Naden 1989). However, this pattern is not attested in Samue. In the present study, I do not speculate further on the origin of the alveolar flap, as the diachronic development of the language is unknown.

(144)	***Gloss***	**Singular**	**Plural**	***Gloss***		***Gloss***
/kùɾò/	*to lie*	/káɾǎ/	/káɾà-mǎ/	*hook*	/jìlè/	*to enter*
/kúló/	*hunger*	/káálá/	/káálá-má/	*straw mat*	/jìnì/	*to leave*
/kúnú-mú/	*house-s*	/kànì-jǎ̌/	/kànì-mǎ/	*guinea fowl*	/jíɾímú/	*to rub*
/kùɾùkàá/	*chameleon*	/kànà/		*to paddle*		
		/kàlà/		*to go up*		
		/káɾa̋mí-sí/		*to lie*		

The flap sound /ɾ/ may be realized as a flap with a single short closure [ɾ], as a rhotic approximant [ɹ], or as a trill with two phases of vibration [r] (see Figure below for all these options). All these variants are in free variation, although it seems that [r] is more frequent if there is a direct contact with /n/. However, these kinds of words are very rare. In words with [ɹ], the single short closure that occurs in [ɾ] is not realized. Maddieson and Ladefoged (1996) mention that the [ɹ] is characterized by a low third formant value. However, that pattern is not visible in Samue examples. [ɹ] is called a rhotic approximant, and it could thus be called a weakened variant of /ɾ/.

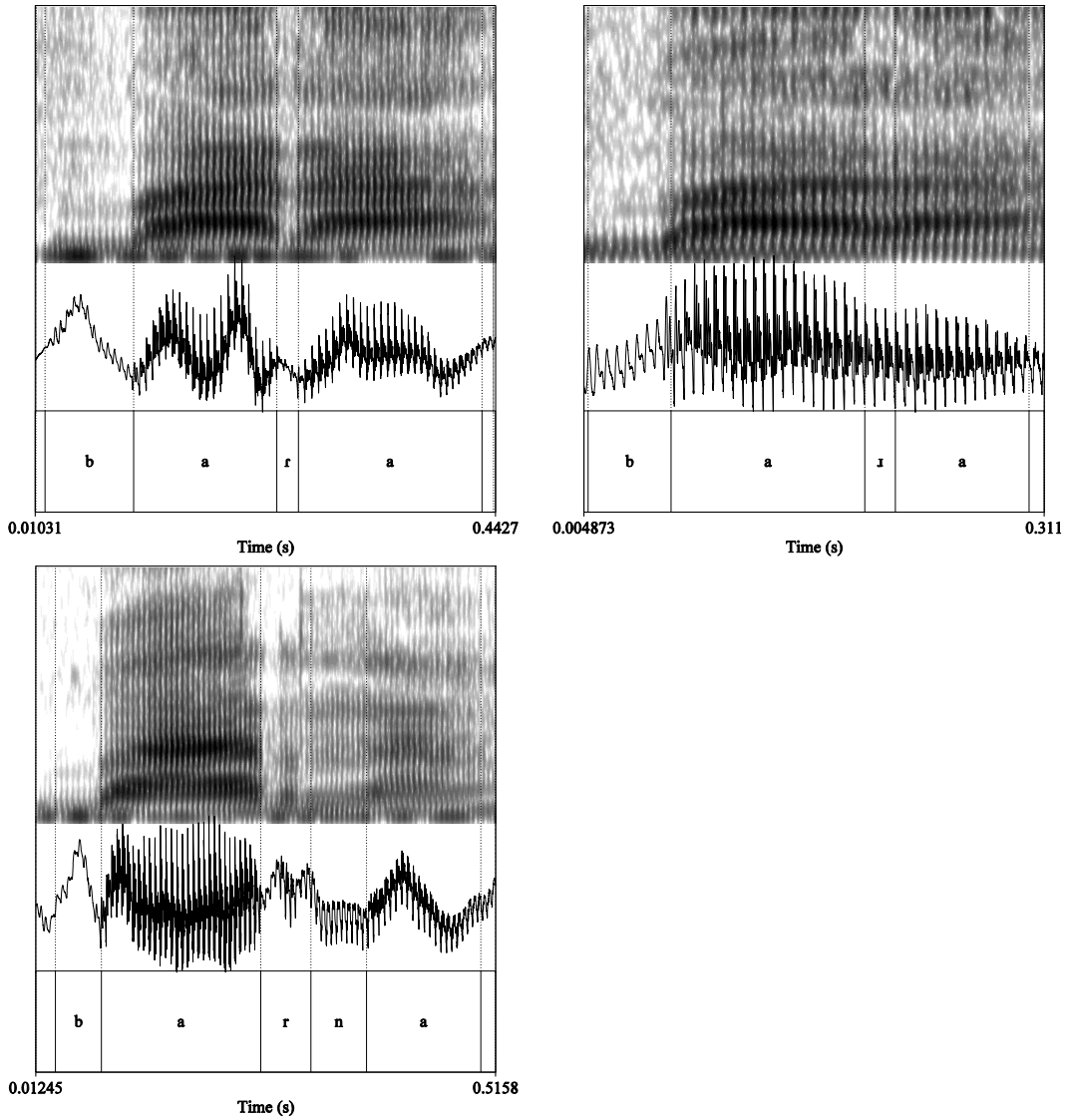


Figure 13. The word /bàrǎ/, *bat*, pronounced with [ɾ] (top left) and with [ɹ] (top right), and the word /bàr̃nà/, *chatting*, with [r] (bottom) (the same female speaker).

In spite of its phonemic status, /ɾ/ is also in free variation with /n/ in some words and among some speakers. However, there are some words where all the speakers prefer /ɾ/ to /n/, such as /jírípìé/, *ant*. Moreover, the sequence of /ɾ/+/n/ may become [nn] or [rr], if the speech rate is fast (see (145) and also 6.4.4). Interestingly, the geminated [rr] has several trills (see also 6.1.7).

(145)

/càɾìnă/	[càɾnă] → [cànnă] or [càrră]	*lion*
/nā̰pōɾōnǐ/	[nā̰pōɾnǐ] → [nā̰pōnnǐ]	*guardian*

The lateral /l/ is attested in word initial and word medial positions between vowels. In both cases, /l/ is contrastive to /n/ as in (146). However, /l/ is in variation with /n/ in medial position, as there are some words where /l/ can be freely replaced by /n/. Some 20 words have this free variation; while in other words, the /l/ is obligatory (see examples of the variation in (147)).

(146)

/l/ and /n/ in contrast:

/lí/	*to kill*	/làkà/	*to open (mouth)*	/kúló-sé/	*hunger-s*
/nì/	*to drink*	/nákā́/	*to travel*	/kúnú-mú/	*family-s*

(147)

Examples of words where [l] only is attested:		Examples of words with variation:		
[kílě]	*hand*	[símílè]	or [símínè]	*shirt*
[plíbé]	*child*	[jàllá̰á]	or [jànná̰á]	*to run (IPFV)*
[bílě]	*loincloth*	[kèlèkè]	or [kènèkè]	*to caress*
[kèlě]	*herd*			
[wálá]	*rain*			

Both /l/ and /ɾ/ occur only after an oral environment, but they can be followed by a nasal. It is possible to speculate that there is a change in progress, where the contrast between liquids and maybe the nasal /n/ is diminishing. In some Gur languages, nasal consonants are not phonemic, but allophonic realizations of resonant consonants (Clements & Rialland 2007) (see more in 4.1.1). In Samue, the situation is not the same as this, i.e. liquids and nasals are phonemic. There is no information about the diachronic development of the language, and for that reason there is a possibility that the complementary distribution of nasals and liquids was the reality earlier in Samue, or that the losing of this contrast will occur later in time because of the variation that exists between liquids and nasals. In Samue, there is a strong tendency for lenition in different manners of articulation. However, if there is variation from liquids to nasals, the process is

opposite, as nasals are considered to have less sonority than liquids in the sonority scale (e.g. Selkirk 1984).

The lenition of /ɾ/ to [ɹ], as illustrated in (150), can be analyzed with the same type of constraints as stop lenition. However, AGREE[cons] and IDENT[cons] constraints are employed, as both [ɾ] and [ɹ] are [+continuant]. The major class feature [consonantal] makes a distinction between consonants and vowels; approximants are considered [-consonantal]. The [ɹ] as an approximant is [-consonantal], whereas [ɾ] is [+consonantal]. The free variation between the flap [ɾ] and the trill [r] will not be further examined.

(148) AGREE[cons]: assign a violation mark for all adjacent consonants in medial position which differ in feature [consonantal]

(149) IDENT[cons]: assign a violation mark for all adjacent consonants in medial position which differ in feature [consonantal]

(150) AGREE[cons], *OBS[+voiced] » IDENT[cons]

/bàɾă/	AGREE[cons]	*OBS[+voiced]	IDENT[cons]
i. ☞ [bàɹă]			*
ii. [bàɾă]	*!		
iii. [bàɣă]	*!	*	*

When lenition applies, AGREE[cons] must dominate IDENT[cons], and thus /ɾ/ is realized as an approximant in intervocalic position. The ranking is reversed, if the faithful candidate [bàɾă] will win.

6.1.5 Approximants

Two approximants are phonemic, namely palatal /j/ and labial-velar /w/ (see Figure 14). They both are attested in initial and medial positions, but /j/ is found in medial position only on onsets of morpheme boundaries, such as noun class suffix or verbal extensions, but not in stems. Sometimes in word initial position, /j/ is very weak, nearly non-existent. It seems that the status of /j/ is weak. This is seen by dialectal variation of /i/ and /u/. A word starting with /j/ in Negeni and followed by a /ĩ/, is pronounced with [ũ] preceded by [w] in Niansogoni (see (151)).

(151)

Niansogoni	**Néguéni**	***Gloss***
[wṹsō]	[jĺsō]	*to get up*

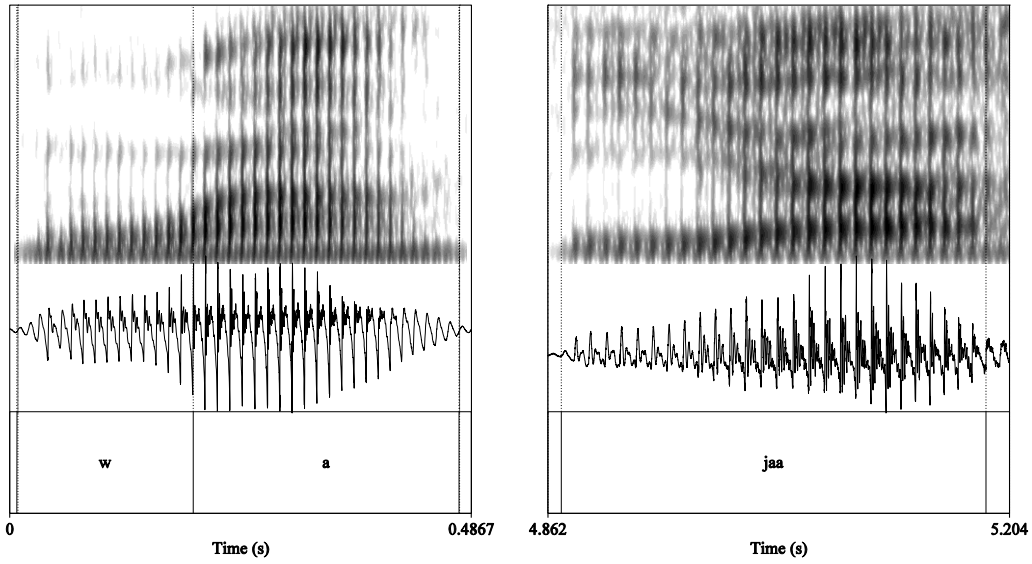


Figure 14. The words /wāá/, *large field* and /jàá/, *song*.

6.1.6 Nasal + stop sequences

6.1.6.1 Data

In Samue, there are words where an NC sequence is attested after an oral vowel word-internally. Some of these words can be contrasted with words where a nasal vowel is followed by a stop (see in (152) and Figure 15), although this kind of pairs are rare.

(152)

[kǻgā̄]	*flying ant*	vs.	[kāŋgá]	*molar*
[jǐ́gá]	*fig tree*	vs.	[jíŋgă]	*face*

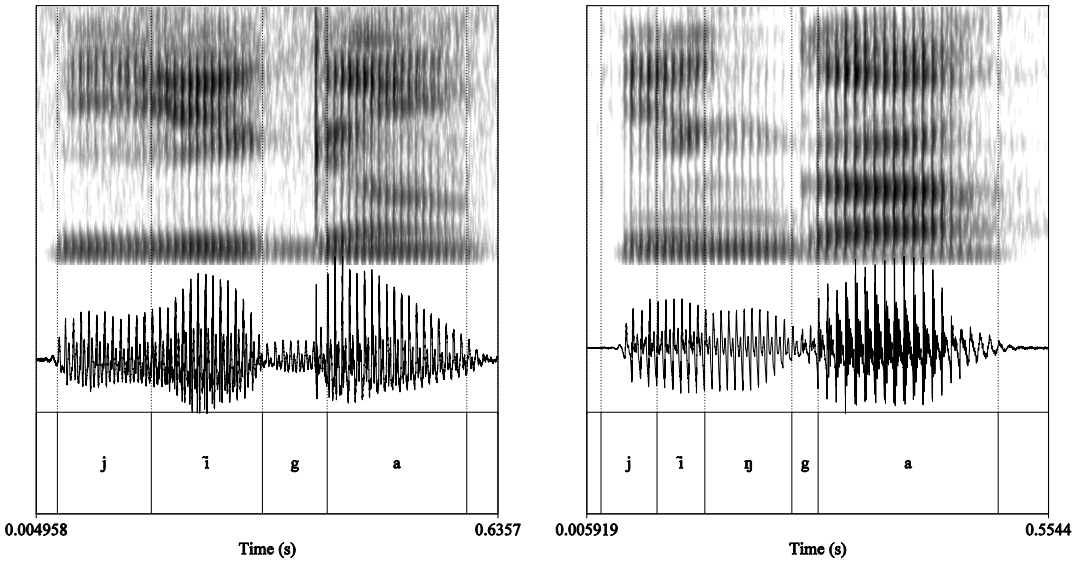


Figure 15. The words [jĭ́gá], *fig tree*, and [jíŋgă], *face*.

In Samue, open CV or CVV syllables are the preferred syllable type (see also section 6.3.1), and all words in Samue end in a vowel. In rapid speech, the lateral /l/ and the flap are attested in coda position word-internally. Additionally, nasals are found in codas, especially in the morpheme boundaries in noun-adjective compounds. There are also simple lexical items that have a nasal followed by a consonant word-internally. This is the case especially with mid vowels /e, o, ɛ, ɔ/. The phonological nasal versus oral feature contrast of mid vowels does not exist anymore (see more on nasal vowels of Samue in section 6.2.3). It seems that the mid nasal vowels existed previously, but are lost their phonological status, and thus CṼCV words have developed into CVNCV words. In some Kwa (Niger-Congo) languages, the mid nasal vowels do not exist; Hyman (1972) hypothesizes that it may be due to historical sound changes where the vowels of the noun class suffix, preceded by a nasal consonant, were developed into nasal vowels at the same time, thus deleting the nasal consonant. However, these suffixes did not include /e/ and /o/ vowels, the reason why the mid nasal vowels are not attested in these languages.

In Samue, the process seems to be different, as the nasal vowels are hypothesized to be developed into vowel-nasal sequences. The result in Samue is a more complex syllable structure in the language (i.e. CVN), but a simpler phonological vowel system with more perceptually salient contrasts as the mid-vowels do not contrast nasal versus oral features (see the previous discussion on nasals and NC-sequences in 4.1.3). The more perceptually salient high and low vowels are contrastive to the feature [nasal] as will be discussed in 6.2.3.

When the words including NC-sequence in Samue are syllabified by native speakers, the nasal often belongs to the same syllable with the following stop creating a NC onset. In syllabified

words, the nasal bears the tone of the preceding TBU (as in word [kpàndāànă], *girl*), and not a distinct tone for itself. Some studies have used speaker intuition as a reasoning to the prenasalized stop analysis of NC sequences (e.g. Casali 1995b), but other studies have found inconsistencies in native speaker judgments (e.g. Riehl 2008). Thus, it may be misleading to make an interpretation solely based on speaker intuition. The open syllable structure at the end of the words in Bantu languages may be caused by the fact that the native speakers of Bantu languages often syllabify NC sequences belonging to the onset of the following consonant. Thus, in syllabified words, a syllable followed by a short pause is considered as a word, respecting the vowel ending word structure of the languages in question (Downing 2005). This may as well be the case in Samue. In Samue, NC sequences also exist in morpheme boundaries in the case of a morpheme that consists of a syllabic nasal solely; this may also affect the native speaker intuition of syllabification.

In a word initial position, there are some grammatical words and also one or two nouns, where NC sequence is attested in Samue. There are two verbal particles [ndē] (past tense) and [ndā] (habitual future) having the same tone throughout the morpheme. These particles could be analyzed as having a prenasalized stop in a word initial position or the nasal could be considered as syllabic. Because of the rarity of these types of words, the interpretation that the verbal particles have a syllabic nasal is adopted. Some relative pronouns have initial NC sequences, where the nasal bears a different tone that the following TBU, and it is thus syllabic, as presented in (153). The nasal in those cases is a separate morpheme altogether. NC sequences are also found in an initial position in one or two nouns. In a word initial position it is possible to speculate that the nasal part is a historical prefix, because it bears a different tone than the following syllable. This nasal is syllabic and not a prenasalized stop or tautosyllabic NC sequence.

(153)

[ŋ̀.gā́.gà]	*non-human singular relative pronoun*
[ŋ̀m̀.g͡bɛ̄ŋ̀m.g͡bɛ́]	*human singular relative, used without antecedent (those who)*
[n̄.dē]	*remote past*
[ŋ̀.góò]	*owl (sp)*

According to this interpretation, the NC sequences occurring in a word-internal position in Samue do not consist of a single segment, or a unary prenasalized consonant, but of a sequence of two consonantal elements belonging to two different syllables. This interpretation creates a CVN syllable structure, which is sometimes attested in the language. However, as previously stated, homorganic nasals in coda position are the least marked coda consonants (see section

4.1.3). The nasal is the only possible coda consonant in Samue, although liquids are attested in that position, but only if the speech rate is fast.

6.1.6.2 Analysis

The words including the NC sequences in Samue can be analyzed by syllable structure constraints, namely *COMPLEX and *CODA. *COMPLEX prohibits complex syllable onsets (154), and *CODA does not allow coda consonants (155). UNIFORMITY constraint prohibits the NC sequence from surfacing as a unary segment, which would create coalescence of nasal and stop features (see (100) earlier). Furthermore, the MAX(S) constraint is employed to preserve input segments.

(154) *COMPLEX: assign a violation mark for every tautosyllabic onset cluster
(155) *CODA: assign a violation mark for every coda consonant
(156) MAX(S): assign a violation mark for every input segment which is deleted in the output

The NC syllabification is illustrated in (157). The tableau illustrates that MAX(S), *COMPLEX and UNIFORMITY dominate *CODA constraint. The faithful candidate [kaŋ.ga] wins, as it does not violate higher ranked constraints. Candidates that violate UNIFORMITY, violate also MAX(S), although the feature [nasal] is kept.

(157) MAX(S), *COMPLEX, UNIFORMITY » *CODA

/kānká/	MAX(S)	*COMPLEX	UNIFORMITY	*CODA
i. ☞ [kaŋ.ga]				*
ii. [ka.ŋga]		*!		
iii. [ka.ᵑga]	*!		*!	
iv. [kã.ga]	*!		*!	

The nasal coda in Samue is considered to share the mora with the preceding vowel (see section 4.1.3, and Downing 2005). In this study, a more detailed analysis of moraic structures of CVN syllables is not presented. However, in the general syllable structure analysis, the number of moras or sharing of moras is discussed (see section 6.3.1.5).

6.1.7 Long consonants

Two consonants, alveolar nasal /n/ and alveolar lateral /l/ can be phonetically long in inflected verb forms, when the imperfective aspect and the future tense are created by a syllable having onset consonant /n/ or /l/. In this case, the syllable onset of the suffix is geminated, as mentioned earlier with verb classes (3.4.1.4). Concerning the /l/, only two verbs are found, but the phenomenon is frequent with /n/. It is possible to state that the suffix begins with a geminate consonant, so that the IPFV suffix would be /nnee/ or /llee/, instead of /nee/ and /lee/. This will be discussed more in 6.3.1.2; the length variation of the last example in (158) is discussed in 6.4.5. Moreover, /ɾ/ in contact with the alveolar nasal /n/ may have a geminated form, [nn] or [rr].

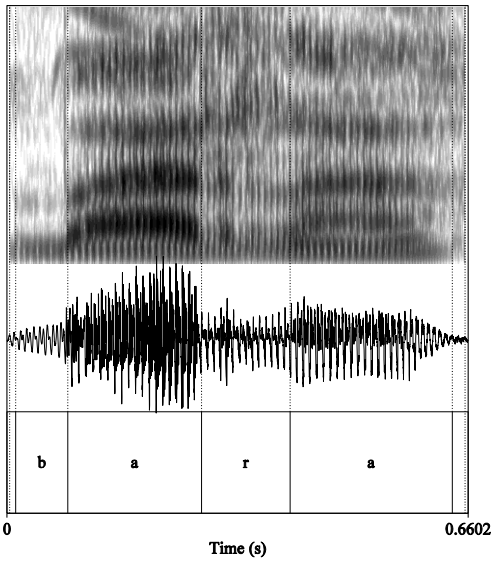


Figure 16. A geminate [rr] in word /bàɾ̄nà/, *chatting*, pronounced [bă̄rrà].

(158)

IMP	**IPFV**	**FUT**	***Gloss***
[kàlà]	[kāllēē]	[kàllè]	*to go up*
[jàlà]	[jāllēē]	[jàllè]	*to run*
[mání]	[mānnēē]	[mànnè]	*to talk*
[násí]	[násínnēē]	[nàsìnnè]	*to fear*
[tɛ̄ɛ́]	[tɛ̄ńnēē]	[tɛ̀ńnè]	*to accustom*

The formation of geminate consonants in Samue is conditioned by morphology, as the only case of long consonants is attested in inflected verb forms. The case of a double [rr] can be analyzed as a form of assimilation. In Samue, only sonorant consonants are allowed to be long. For this reason, for example the rare IPFV suffix -see does not engender a geminate consonant.

6.1.8 Section synthesis

A very clear **characteristic of the consonant system in Samue is the voicing and the weakening of the obstruents in a word-medial position**. The weakening also concerns the flap sound /ɾ/. Another characteristic is the free variation between voicing and weakening in word-medial positions. Although the tendency of voicing and lenition is high, free variation exists and sometimes the same words are pronounced by the same speaker with a voiceless stop, a voiced stop or an approximant. The consonant lenition for Gur languages is mentioned by Naden (1989), especially for the velar stop. In Samue, however, several consonants display the weakening process. As a summary, a table of consonant phonemes is given with allophonic variations and free variants (see Table 5).

Table 5. Summary table of consonants (phonemes, allophones, free variation).

Phoneme	**Allo-phones**	**Phonetic realizations**	**Initial position**	**Medial position**	**Free variation**
/p/	[p]	[p], [b]	[pā] *to come*	[pámbáà] *traditional can*	between [p] and [b] in medial position
/b/	[b]	[b], [β̞]	[bá] *to help*	[cíīβ̞ě] *woman*	between [b] and [β̞] in a medial position
/m/	[m]	[m]	[mà] *to hit*	[nàmìnă] *scorpion*	-
/f/	[f]	[f]	[fa͂a͂] *sweet pea*	[kafana]	-
/t/	[t]	[t], [d]	[tàá] *rock*	[lèndáá] basket	between [t] and [d] in a word-medial position

Phoneme	Allo-phones	Phonetic realizations	Initial position	Medial position	Free variation
/s/	[s], [ʃ]	[s], [ʃ], [z], [ẓ]	[sáà], [ʃíà] *rice field, big brother*	[káázá] *broom*	especially between [z] and [ẓ] in a medial position
/n/	[n]	[m], [ɲ], [ŋ], [ŋ͡m]	[náá] *mouth*	[múnùkǔ]	[m], [ɲ], [ŋ] and [ŋ͡m] by assimilation only
/l/	[l]	[l], [n]	[làá] *place*	[káálá] *big straw*	in some words with [n]
/ɾ/	[ɾ]	[ɾ], [r], [ɹ]	-	[káɾă] *hook*	between all the variants, in some words with [n]
/c/	[c]	[c], [ɟ]	[cáá] *rainy season*	[i̯ɟá] *embers*	not always voiced in the medial position
/j/	[j]	[j], [ɲ]	[jáá] *year*	[kpííjé] *man*	-
/k/	[k]	[k], [g], [ɯ]	[káà] *baboon*	[bóógǒ], [bóóɯǒ] *village*	between [k], [g] and [ɯ] in a medial position
/k͡p/	[kp]	[kp], [gb]	[k͡páá] *dryness*	[k͡pēg͡bɛ̀ɛ̄ná] *rust*	between [kp] and [gb] in a medial position
/w/	[w]	[w]	[wáà] *shea*	[túúwá] *liver*	-

Samue employs the five places of articulations which are attested in many Gur languages (Naden 1989). Besides the remarkable lenition process, the fact that both /l/ and /ɾ/ are phonemes in Samue is somewhat surprising, as the flap sound is often a non-initial allophone of /d/ in Gur languages (Naden 1989). Moreover, **Samue does not make a phonemic distinction between voiceless and voiced stops**, except for the bilabial /b/.

Consonant phonemes display some specific cases in Samue that affect the OT analysis. The question of voicing and lenition of stops illustrates a case of variation. Thus, a fixed ranking hierarchy of the constraints cannot be given for the constraints IDENT[cont], AGREE[cont] and *OBS[+Voiced]. However, AGREE[voice] dominates IDENT[voice]. The stop stays voiceless in a

morpheme initial position, which was analyzed by the positional faithfulness constraint IDENT[voice]$_{mi}$. In NC sequences, the basic syllable structures constraints are employed. The ranking reveals that MAX(S), *COMPLEX and UNIFORMITY are higher ranked than *CODA. This is further confirmed in section 6.3.1.5 with syllable structures. Palatalization of the fricative /s/ is a distinct case with two constraints PAL-I-[-high] and IDENT[ant]$_{c}$. These two constraints are not related to other constraints used in the consonantal analysis in a significant way.

6.2 Vowel phonemes

In Samue, there are seven short oral vowels distinguished by four vowel heights: high /i/ and /u/, mid-high /e/ and /o/, mid-low /ɛ/ and /ɔ/, and low /a/. Each of them has a long equivalent. Additionally, three vowel qualities are attested as nasal vowels, short and long, namely the high and low vowels: /ĩ/, /ũ/ and /ã/. See Table 6 for the vowel phonemes.

Table 6. Vowel phonemes.

		Front		Central		Back	
High	**oral**	i	ii			u	uu
	nasal	ĩ	ĩĩ			ũ	ũũ
Mid-high	**oral**	e	ee			o	oo
Mid-low [-ATR]	**oral**	ɛ	ɛɛ			ɔ	ɔɔ
Low	**oral**			a	aa		
	nasal			ã	ãã		

6.2.1 Oral vowels

The seven short oral vowels can be contrasted in semi-minimal pairs (see (159)). In Annex 2, the minimal pairs of all oral vowel contrasts are illustrated.

(159) Contrasts of short oral vowels

/i/	**/e/**	**/ɛ/**	**/a/**	**/ɔ/**	**/o/**	**/u/**
k͡písí	**k͡pēɾé**	**k͡pɛ̄ɾɛ́**	**k͡pásá**		**k͡pólókó**	
to finish	to shorten	to poison	to flee		to shell	

/i/	/e/	/ɛ/	/a/	/ɔ/	/o/	/u/
kílě hand		**kɛ̀lɛ̀kɛ̀** to caress	**kàlà** to go up	**kɔ̄kɔ̄-bɛ́** plant-pl (sp)	**kólónkálà** snail	**kúló** hunger
kīrīkīnī now	**Kènú** God	**kɛ́ɾɛ̀-bě** bambara nut-pl	**káɾà-bě** hook-pl	**kɔ̀ɾɔ̀kàá** roughcast (sp)	**kónú-mú** family hut-pl	**kúɾù-mă** mort-pl
wí-má pond-pl	**wè-mŭ** thing-pl	**wɛ́-jīī** to crush	**wànì** to cook	**wɔ̀nì** to eat	**Wótù** Outtourou (proper name)	**wúmú** to bite
cì to walk	**cé** to look at	**-**	**cá** to ferment	**cɔ́mí** to stab	**cómí** to winnow (with a basket)	**cúǹ** little
kísí-ná insect (sp)	**kètèkètè-mŭ** tom-tom-pl (sp)	**kēsī** to separate	**kásá-ná** young animal not yet produced	**kɔ́sɔ́-mí** to ruin	**kósó** to scold	**kúsù-mŭ** pregnancy-pl

There is some variation between the high vowels /i/ and /u/, as words having an /i/ can be pronounced with /u/. For example, the verb /tìkì-ní/, *to put*, can be pronounced [tìgì-ní] or [tùgù-ní], where the final vowel of the verbal extension does not change. This variation between high vowels is more frequent in the dialect of Néguéni, where most of the words having /u/ in Niansogoni are pronounced with /i/, and the noun class **-nu/-mu** is systematically **-ni/-mi** in the Néguéni dialect (see some examples in (160)). There are some other dialectal differences between vowels /a/ and /ɛ/. However, these differences are not discussed in more detail in this study.

(160)

Niansogoni	**Néguéni**	***Gloss***
númú	nímí	*water*
múnùgŭ̌	mínìgĭ̌	*nose*
wŭ́só	jĭ́só	*to get up*

The vowel /i/ has a tendency to become very short between stop and lateral, as in the word /kílě/, *hand*, which can be pronounced [k̟ílě] or [kĺě]. In that position, /i/ is sometimes deleted (see more in section 6.4.4). Other vowels do not display this kind of change.

Since the focus of this study is on the phonological system of Samue, all the phonetic and acoustic details of the sound segments are not discussed. However, the average formant values of oral vowels are presented in Table 7 with standard deviations. The measurements were made from the wordlist containing 52 words; the wordlist was pronounced twice by 12 different speakers (6 female). The measurements presented here are taken from the first syllable in the word, and thus the vowel follows a consonant (see details of the data analysis in 2.4.2). There is some variation in the total number of items analyzed per vowel quality because of some noisy data (N denotes the number of items in the Table below). Furthermore, the vowel /i/ and /a/ were more frequent in the first syllable position than other vowel qualities. The formant values F1, F2 and F3 in Hertz were measured, except for the vowel /u/, for which only F1 and F2 values were analyzed. This is due to the articulation of the high back vowel, which has relatively low formant frequencies for both F1 and F2, and the F3 may be of very low amplitude and thus indistinguishable.

Table 7. Average formant values (F1, F2, F3) and standard deviations (Dev) of oral vowels.

	Female subjects						
	N	**F1**	Dev	**F2**	Dev	**F3**	Dev
i	84	**341**	47	**2365**	248	**2956**	193
e	19	**380**	29	**2268**	186	**2908**	138
ɛ	24	**547**	61	**1961**	172	**2897**	227
a	97	**781**	94	**1613**	110	**2826**	201
ɔ	32	**547**	55	**1244**	137	**2786**	215
o	33	**401**	38	**1020**	191	**2876**	181
u	39	**351**	36	**1003**	169		
	Male subjects						
	N	**F1**	Dev	**F2**	Dev	**F3**	Dev
i	79	**286**	34	**2119**	129	**2901**	245
e	20	**346**	25	**2023**	159	**2644**	120
ɛ	34	**511**	51	**1706**	167	**2657**	171
a	86	**636**	74	**1391**	93	**2670**	195
ɔ	25	**512**	36	**1178**	86	**2683**	151
o	36	**390**	24	**927**	146	**2580**	198
u	31	**316**	68	**876**	143		

Within female speakers, the high and mid-high vowel formant values are partially overlapping (see Figure 17, the left side). /a/ is clearly a central vowel with relatively high F2-values. The

mid-low vowels /ɛ/ and /ɔ/ are very equally open, as the F1 values reveal for the average value, whereas the mid-high vowels /e/ and /o/ show some variation. The average formant values by speaker are presented with a smaller font, and the average values for all female speakers are marked with a larger font in bold in Figure 17. Within the male speakers, /i/ seems to be closer than /u/, and /e/ seems to be closer than /o/, whereas the mid-low vowels have the equal openness level according to the F1 value. This is illustrated in Figure 17 (right side), where the average formant values by speaker are marked with a smaller font, and the average values for all male speakers are marked by a larger font in bold. The figures present raw data from Table 7 that is not normalized.

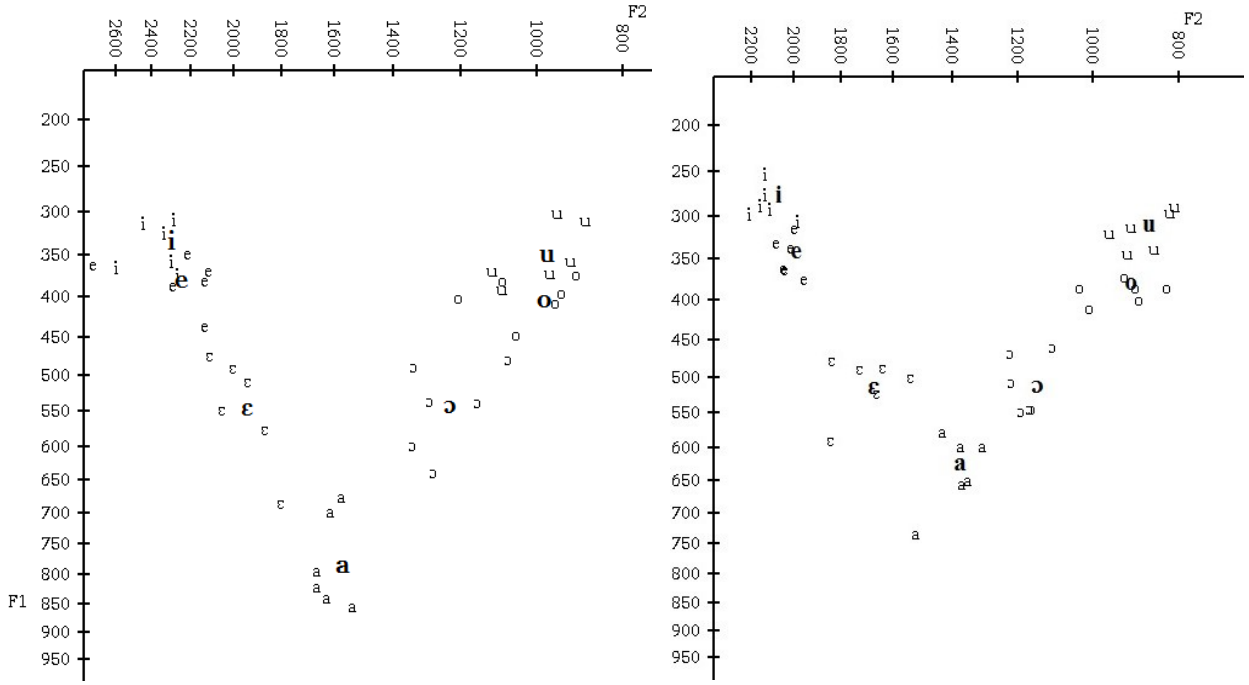


Figure 17. Average F1 and F2 values for female speakers (left) and for male speakers (right). Averages by speaker are marked in a smaller font, and averages for the whole group are bold in a larger font.

In general, the high vowel /i/ and mid-high vowel /e/, as well as the high vowel /u/ and mid-high vowel /o/ are acoustically close to each other. Individual variation is also rather large, as for example some female speakers' /i/ and /u/ have approximately the same formant values than other speakers' /e/ and /o/, respectively. Both these phenomena are also reported in other African languages. Starwalt (2008) in her study of ATR vowel harmony in eleven Niger-Congo languages showed large individual variation and partly overlapping high and mid-high vowels, whether [+ATR] or [-ATR]. The analysis of Kɔnni vowels (Gur, Ghana) by Cahill (2007a) also illustrates strong overlapping values of high and mid-high vowels.

6.2.2 Long vowels

All seven long vowels can be contrasted among themselves, as shown in (161). Short and long vowels can also be contrasted (see (162)). It is somewhat difficult to find exact minimal pairs to contrast long and short vowels, especially in nouns, because of the different noun class suffixes, and also because monosyllabic stems are mainly bimoraic, i.e. they have a long vowel. For that reason the contrasts between long and short vowels are given separately for verbs in the imperative mood (163). Long vowels are less frequent than short ones, especially mid vowels (mid-low and mid-high).

(161) Contrasts between long vowels

/ii/	/ee/	/ɛɛ/	/aa/	/ɔɔ/	/oo/	/uu/
cìì-nŭ	**céékén-ní**	**cɛ̄ɛ́-ná**	**cāā-ná** **káá-já**	**kɔ̄ɔ̄-ná**	**kóó** **k͡póò-nŭ**	**kúú-nú**
edge of the rice field	player	spatula (sp)	friend (fem.) sick	left hand	head, bird (sp)	crocodile
mìì-bá	**béé-nú**	**béɛ́-má**	**báá-ná**	**bɔ́ɔ́-ná**	**bóókŏ**	**búú-nú**
rice	stool	balafon	bridge	friend	village	horn

(162) Contrasts between short and long vowels in nouns

/ii/	**/i/**	**/uu/**	**/u/**
cíì-ma	**cì-mă**	**tùùkó-mú**	**túkú-mú**
woman-pl	firewood-pl	family-pl	flour-pl
/ee/	**/e/**	**/oo/**	**/o/**
wèé-mŭ	**wè-mŭ**	**póókó-sĕ**	**lōkō-sé**
slave-pl	thing-pl	caterpillar-pl	chain-pl
/ɛɛ/	**/ɛ/**	**/ɔɔ/**	**/ɔ/**
kpɛ̄ɛ̄-nà	**kpɛ̄-já**	**kɔ̀ɔ̀là-mă**	**kɔ̀nì-mă**
stupid (pej.)	big straw	cough-pl	guitarre-pl
/aa/	**/a/**		
láákă	**lákă**		
rice field plot	fold		

(163) Contrasts between short and long vowels in verbs

/i/	/ii/	/u/	/uu/
cí	**cíí**	**pù**	**púú**
to weave	to insult	to bury	to urinate
/e/	**/ee/**	**/o/**	**/oo/**
lèmì-ní	**léémí-ní**	**wòkò**	**tóókó**
to taste	to illuminate	to guard	to send
/ɛ/	**/ɛɛ/**	**/ɔ/**	**/ɔɔ/**
tɛ̄	**tɛ̄ɛ́**	**kɔ́mí-ní**	**kɔ̀ɔ̀kɔ̀-ní**
to mash	to accustom	to lay down	to weed
/a/	**/aa/**		
wá	**wáá**		
to lock up	to plough rice field		

6.2.3 Nasal vowels

Nasality is a distinctive feature in Samue. Nasal vowels are phonemic in comparison with oral vowels. However, only high and low vowels have a nasal counterpart, see (164) for nasal contrasts among nasal vowels and (165) for contrasts between oral and nasal vowels. The low nasal vowel /ã/ is the most frequent. Some more minimal pairs are given in Annex 2.

(164)

/ĩ/	/ã/	/ũ/
tĩ̀té	**tã̄sísá**	**tũ̀táá**
instrument (sp)	frog	wasp
sĩ̀sě	**sã̀sé-nú**	**wű́sò**
shame	needle	to get up

(165)

/i/	/ĩ/	/u/	/ũ/	/a/	/ã/
pí-sé	**pĩ́-sé**	**kúgù-nă**	**kű́gú-ná**	**ságá**	**sã̀gã̀**
child-pl	horn-pl	louse	hillock (yam field)	to wash	to grow up

The high and low nasal vowels are attested in Samue, which creates a perceptually salient contrast between nasal vowels in the acoustic vowel space. The potential nasal mid vowels, if distinguished as mid-high and mid-low vowels, would already be perceptually very close to each other, because of the movements of the velum together with jaw and tongue movements in different vowel qualities (e.g. Krakow et al. 1988). It is also attested that in the languages of the different parts of the world, nasal vowel qualities are subject to sound changes in the form of neutralization or raising and lowering (e.g. Bhat 1975). Hyman (1972) reports that in many Kwa languages the mid vowels [e] and [o] do not occur nasalized; i.e. there are less nasal than oral vowels. It is possible that the mid-high and mid-low nasal vowels have earlier had phonological status in Samue. Nowadays, mid vowels are somewhat nasalized when preceding a nasal consonant, as previously mentioned with the analysis of NC sequences (see 4.1.3 and 6.1.6 for Samue). In this nasal environment, however, they are considered as oral vowels, which become partially nasalized in the nasal context.

Three long nasal vowels are attested, namely /ĩĩ/, /ũũ/ and /ãã/. They contrast with long oral vowels (see (166)).

(166)

/ĩĩ/	/ii/	/ãã/	/aa/	/ũũ/	/uu/
wḯḯ-jǎ̀	**wíí-jè**	**sǎ́ǎ́**	**sáà**	**tṹṹ-wá**	**túú-wá**
oil, fat	straw	stalk	rice field	honey	liver

6.2.4 Section synthesis

Four vowel heights are attested in Samue creating a system, where seven oral vowels can all be contrasted as short and long vowels. The number of vowels vary largely in Gur languages, e.g. in the Grusi sub-group of Central Gur languages 9- or 10- vowel systems are common, whereas in other sub-groups the 7-vowel systems are more frequent (e.g. Dakubu 1997). **The nasality is a distinctive vowel feature**, but the nasal opposition is kept only in maximally different vowels, i.e. high and low nasal vowels are phonemic in Samue. This tendency to have fewer nasal than oral vowels is attested in Niger-Congo in general (e.g. Williamson 1989), and also in Gur languages (Naden 1989). Naden (ibid.) suggests that proto-Gur may not have had contrastive nasal vowels at all, but some researchers have proposed that proto-Niger-Congo may have had nasal vowels (Williamson 1989).

The vowel system in Samue is clear, and vowel phonemes in word-medial positions are stable, in contrast to the consonantal system. However, in morphemes boundaries, vowels exhibit some morphophonological processes, such as vowel harmony and vowel coalescence, which will be

discussed and analyzed later (see section 6.4). It is true that vowel harmony may also affect the verb and noun stems, but because of the nature of the harmony process, it is examined later as a part of the phonological processes.

6.3 Phonotactics

In this section, syllable structures of the Samue words, as well as the frequency of phonemes in simple words (noun stem + suffix and imperative verb forms) are presented. Furthermore, the co-occurrence of consonant phonemes is examined, and the possible consonant and vowel sequences. Vowel harmony is discussed separately in 6.4.2 with other phonological processes.

6.3.1 Syllabic structures

All possible syllable structures are presented in this section, including structures found in pronouns and grammatical words. First, the word structure of nouns and verbs are discussed separately.

6.3.1.1 Word structure of nouns

The syllabic structures of nouns are shown below by the number of syllables (see (167)). The noun class suffix is separated from the stem by a hyphen in the examples and a dot (.) denotes a syllable boundary. Monosyllabic nouns always have a long vowel; they consist of two moras. In most cases, the monosyllabic stems are also composed of two moras, having the word structure CVV.-CV. Thus, the word structure CV.-CV is rare in nouns. Disyllabic stems are CV.CV, CVV.CV or CV.CVV. Trisyllabic stems are CV.CV.CV or CV.CV.CVV. Stems of four or more syllables are rare and they are always formed by reduplication. The noun class suffix is either -CV or -V. The analysis of the CV-V structure with diphthongs will be discussed in more detail in 6.3.5.

(167)

Monosyllabic roots

Syllable structure	Example	*Gloss*
CVV	**cáá**	*rainy season*
	káà	*shell*
	sì-é	*tree*
CV.-CV (rare)	**cì.-nǎ**	*wood*
CVV.-CV	**wíí.-jè**	*straw*
	lìè.-nǔ	*thirst*
Disyllabic roots		
singular suffix ∅		
CV.CV	**wá.lá**	*rain*
CVV.CV	**káá.kǎ**	*tortoise*
CVN.CV	**kān.ká**	*molar*
with singular suffix		
CV.CV.-CV	**kí.sí.-ná**	*spider (sp)*
CV.CV-V	**nā́.kù-á**	*millipede*
CVV.CV.-CV	**fúú.kú.-nú**	*snake (sp)*
CVN.CV.-CV	**kōn.kō.nú**	*funeral instrument (sp)*
CV.CVV.-CV	**mā̰.céé.-nú**	*papaya*
Trisyllabic roots		
CV.CV.CV.-CV	**cà.kū.sū.-ná**	*avarice*
CV.CV.CV-V	**jú.kú.pí-é**	*eye*
CV.CV.CVV.-CV	**pì.lì.jáá.-ná**	*squirrel*
Roots with four or more syllables		
CV.CV.CV.CV.-CV	**fù.kó.fù.kó.-nú**	*lung*
CV.CV.CV.CV-V	**kò.kò.kà.pí-é**	*beetle*
CV.CV.CV.CV.CV.CV	**bà.wū.nā.wū.nā.-ná**	*fly (sp)*

Very few nouns begin with a vowel; altogether 23 words are attested among 410 simple nouns. All the possible structures of vowel initial words are given in (168) below.

(168)

Word structure	Example	*Gloss*
V.CV	**ḭ̀.cá**	*embers*
V.CVV	**ī́.nàà**	*shadow*
V.CV.CV	**ḭ̀.nà.kǎ**	*fetish*
V.CVV.CV	**ḭ̀.máá.ná**	*type of pancake with bambara nut flour*
V.CV.CVV	**ā́.wá.pié**	*basket (sp)*
V.CV.CV.CV	**ā́.cú.kú.lá**	*cowrie shell*

6.3.1.2 Word structures of verbs

Word structures of verbs are more restricted than that of nouns. Most of the verbs are monosyllabic (CV or CVV) or disyllabic (CVCV or CVVCV). Some trisyllabic verbs are attested; they have only short vowels (CVCVCV). All verbs are consonant initial.

The imperative as the simplest verb form is the verbal stem (see (169)), except for the disyllabic verbs, where the final vowel changes between perfective/imperative (PFV/IMP) and imperfective (IPFV), as seen previously. In this case the stem is considered as being consonant final, e.g. CV.C-. In disyllabic verbs, the verb stem is then either vowel final CV(V).CV or consonant final CV(V).C-. If the stem is consonant final, a vowel is attached to the stem to create inflected forms; the quality of the final vowel is different between perfective/imperative and imperfective forms.

(169)

Monosyllabic CV(V)		**Disyllabic** CV(V).CV		**Trisyllabic** CV.CV.CV	
nì	*drink*	**là.kà**	*open the mouth*	**wú.sú.mấ**	*shine*
céé	*look at*	**táá.ká**	*approach*		
		CV(V).C-		**CV.CV.C-**	
		tì.k-	*put*	**tè.rè.k-**	*apply*
		pèè.k-	*watch*		

In verbal morphology, onsetless syllables are allowed in the imperfective aspect of monosyllabic verb stems that belong to the verb class defined by inflectional suffixing, which is done by vowel addition (as shown in (170)). The verbal morphology was already discussed in detail in section 3.4.1.2.

(170)

IPFV	*Gloss*
nī.āā	*to drink*
pū.ōō	*to bury*
bū.āā	*to remove*
lī.ēē	*to kill*

The possible inflectional suffix structures of verbs are -V, -VV, -CVV, -NNVV or -CV. These different structures are illustrated below. They do not necessarily form a new syllable, for example the -V addition to a monosyllabic CV verb creates a CVV syllable structure.

(171)

IMP	Suffix	Inflected syllable structure IPFV	*Gloss*
kà	V	**kāā**	*to crunch*
lí	VV	**lī.ēē**	*to kill*
kằ	CVV	**kā̃ā̃.sēē**	*to scratch*
púló	NNVV	**pū.lōn.nēē**	*to be cooked*
		FUT	
mà	CV	**màà.sè**	*to hit*

The monosyllabic CV verbs when having the IPFV suffix -see have their stem vowel lengthened. The stem vowel is long also in the future tense (see the verbs **kằ**, *to scratch* and **mà**, *to hit* in (171)). Thus, all the CV verb stems have bimoraic structure in inflected forms, either because of the suffixal vowel lengthening, or because of the nasal of -NNVV suffix. The monomoraic CV structure exists only in imperative or perfective. The IPFV suffix is analyzed having a long consonant /nn/, because the verbal stem is oral in most of the verbs, which take the -nnee suffix. In other words, it would be more difficult to explain why the /n/ becomes geminated if the suffix is -nee, than to analyze the suffix having a geminated /nn/ in its phonological form. However, there are less than ten verbs, such as **mání-mañnēē** (*to talk* in IMP-IPFV), where the -nnee suffix is attached to the stem nasal final stem, e.g. **man**-, resulting a geminated nasal instead of a triple nasal.

Some monosyllabic CVV verbs belong to the third verb class, which has the IPFV with a syllable addition. Some of these verbs will have the syllable structure CVVN in IPFV, such as the verb **púó**, *to harvest* which is **pūōn.nēē** in IPFV. Nevertheless, these verbs are rare (see more on vowel sequences in 6.3.5).

6.3.1.3 All syllabic structures

The basic syllable structures attested in Samue are the following: V, N, CV, CVV, CVN and VV (see Table 8). The most frequent syllable structures in Samue are CV and CVV. V and N as a word structure are restricted to pronouns and grammatical words. As a part of a longer word, V is attested in a few vowel initial nouns. The VV syllable structure is attested in inflected verb forms only; VV structure is the result of imperfective suffixing in monosyllabic verbs, which end in a vowel, and in which the IPFV is done by vowel addition. The onsetless syllables in word medial position are morphologically conditioned; there is an inflectional verbal suffix -VV or -V. The syllable nucleus in Samue is a vowel or a syllabic nasal. The CVN structure is the only

one with a coda consonant. As discussed with NC sequences, the nasal as a coda position is the least marked consonant.

Table 8. Syllable structures of Samue words.

Frequent structures		
V	**ì**	*3s, he/she*
	ì̀.cá	*embers*
	kù-ò	*to cut (FUT)*
N	**ń**	*1s, I (PFV)*
	ń.tì	*1s, I (IPFV)*
CV	**wá.lá**	*rain*
	bɔ̀	*negation*
CVV	**sàà.-nă**	*sand*
	sì-é	*tree*
VV	**pī.-ēē**	*to ask (IPFV)*
CVN	**kān.ká**	*molar*
Marginal structures		
CVL	**nm̄̄.pōɾ.-nǐ**	*guardian*
CCV	**klá**	*plant (sp)*
CVVN	**sīén.nēē**	*to do purposely (IPFV)*

The marginal structures CVL and CCV found in a few Samue words are attested only in rapid speech; L denotes a liquid sound. The word [**nm̄̄.pōɾ.nǐ**] is [**nm̄̄.pō.ɾō.nǐ**], if pronounced carefully. The CCV structure is found only in one word, **klá**, *plant* (sp). However, in rapid speech the high front vowel between a stop and a lateral is often deleted, like in word /kílě/, *hand*, which is often pronounced [kĺě] (see also 6.4.4 for vowel deletion). Another marginal structure is CVVN, which is found only in inflected verbs having a CV_1V_2 stem. These stems are rare (less than ten verbs).

6.3.1.4 Number of moras

Nouns in isolation are always bimoraic, i.e. monosyllabic nouns are CVV, but the noun stem can be monomoraic CV syllable (cf. **sì-é**, *tree* in singular and **sì.-kpě**, *a big tree*). Monosyllabic verbs can be either mono- or bimoraic (i.e. CV or CVV) in the imperative mood. The heaviest syllable structure in Samue is bimoraic. Normally the bimoraic structure is CVV, but occasionally also CVVN in the IPFV aspect when the IPFV suffix is -**nnee** and the verb stem is CVV (e.g. **púó**, **pūōn.nēē**, *to harvest*). In CVN and CVVN structures, the nasal is analyzed as sharing the mora

with the preceding vowel. In (172), the basic syllable structures of Samue are illustrated with the moraic structure.

(172)

μ	μ	μ μ	μ	μ μ	μ	μ μ
|	|	| |	|	| |	/\	| /\
V	N	VV	CV	CVV	CVN	CV_1V_2N
/ì/	/ń/	/ōō/	/bɔ̀/	/cáá/	/kān/	/pūōn/
3s	1s	in word /kū.ōō/ *to cut* (IPFV)	NEG	*rainy season*	in word /kān.ká/ *molar*	in word /pūōn.nēē/ *to harvest* (IPFV)

6.3.1.5 Analysis of syllable structures

When analyzing syllable structure in Samue, the observation is that faithfulness constraints MAX(S) (as in (156)) and DEP(S) (173) dominate syllable structure hierarchy, as deletion and epenthesis are not favored. *CODA (as in (155)) and ONSET (174) constraints are sometimes violated. However, a coda is allowed only word-internally and only a nasal can be the coda consonant. McCarthy and Prince (1993) employed the CODACONDITION constraint, which restricts codas to a nasal consonant homorganic to a following stop (see (173)). This CODACOND constraint accounts also for the coda realization in Samue. The ONSET constraint is violated in word initial position in some nouns or grammatical words, or in the verbal morphology, as the imperfective suffix can be onsetless VV structure (see more in 6.3.5). The complex onsets are prohibited by *COMPLEX constraints (see (176)).

(173) DEP(S): assign a violation mark for every segment which is epenthesized

(174) ONSET: assign a violation mark for every syllable not having an onset consonant

(175) CODACONDITION: assign a violation mark for every coda that is not a nasal homorganic to a following stop

(176) *COMPLEX (as in (80)): assign a violation mark for every complex onset consisting of more than one segment

MAX(S) and DEP(S) are highly ranked. The examples /ɲ̀icá/ (177), *embers*, and /ì/ (178), third person singular pronoun, illustrate that the winning candidate violates the ONSET constraint, while losing candidates violate higher ranked constraints MAX(S) and DEP(S).

(177) /ìcá/	MAX(S)	DEP(S)	ONSET
i. ☞ [ĩ.ca]			*
ii. [ca]	*!		
iii. [jĩ.ca]		*!	

(178) /ì/	MAX(S)	DEP(S)	ONSET
i. ☞ [ì]			*
ii. [jì]		*!	
iii. [ˋ]	*!		

CODACOND is more specific than *CODA, as only the nasal codas are allowed. This is illustrated in (179) with the word /kānká/, *molar*. The winning candidate violates the low-ranked *CODA constraint only.

(179) /kānká/, *molar*

/kānká/	MAX(S)	DEP(S)	*COMPLEX	CODACOND	*CODA
i. ☞ [kaŋ.ga]					*
ii. [ka.ga]	*!				
iii. [ka.ŋga]			*!		
iv. [ka.ni.ga]		*!			
v. [kag.ga]				*!	*

Consonant final stems in verbs receive a final vowel in inflected forms; the stem-final consonant will then form the onset of the next syllable. This is illustrated in (180) with the stem /pèèk-/, *to watch*.

(180) /pèèk-/-stem (*to watch*) in IMP has a final vowel

/pèèk-è/ stem-IMP	MAX(S)	DEP(S)	CODACOND	ONSET
i. ☞ [pèè.kè]				
ii. [pèèk]	*!		*!	
iii. [pèèk.è]			*!	*

The verbs having a nasal final stem belong to the verb class three and take the suffix -**nnee**. Phonologically, this would result in a triple nasal, e.g. /mán-nnēē/, *talk*-IPFV. However, this kind of output could be prohibited by a markedness constraint *NNN, which does not allow a sequence of three nasals (181). However, it should be ranked above the MAX(S) constraint, which is high-ranked in Samue; see the example in (183). Moreover, the syllabification of a triple nasal would be complicated, because syllabic nasals are normally allowed only in word-initial position. Thus, a constraint prohibiting the syllabic nasal word-medially shoud be created, such as *N_{Med} (182). Otherwise, constraints accounting for a complex coda or a complex onset should be employed (these are not included in (183)).

(181) *NNN: assign a violation mark for every triple nasal sequence

(182) *N_{Med}: assign a violation mark for every word-medial syllabic nasal

(183)

/man-nnee/ stem-IPFV	*NNN	*N_{Med}	DEP(S)	MAX(S)
i. ☞ [man.nee]				*!
ii. [man.nnee]	*!			
iii. [man.n.nee]		*!		
iv. [ma.nin.nee]			*!	

The above analysis is not completely adopted in the present study, because the verbs having nasal ending stems, which take the -**nnee** suffix, could also be analyzed as having a vowel ending stem, e.g. **máni**, and the vowel is deleted in inflected forms (see more on Vowel deletion in 6.4.4). However, there are less than ten verbs like this, although about a hundred verbs take the -**nnee** suffix.

The rare cases of stem internal diphthongs in inflected verbs may be subject to CVVN syllable in imperfective, if the IPFV suffix is **-nnee**. Stem-internally, onsetless syllables are not allowed in Samue. Thus, ONSET dominates the NODIPHTHONG constraint (184). The syllabification of an IPFV verb is illustrated in (185) with the verb *to harvest*.

(184) NODIPHTHONG (NODIPH): assign a violation mark for every tautosyllabic diphthong

(185) /puo-nnee/, *to harvest* in IPFV

/puo-nnee/ stem-IPFV	MAX(S)	DEP(S)	ONSET	NODIPH
i. ☞ [puon.nee]				*
ii. [pun.nee]	*!			
iii. [pu.won.nee]		*!		
iv. [pu.on.nee]			*!	

In Samue, in the case of a CVVN structure, the nasal shares the mora with the preceding vowel. In moraic theory, geminate consonants are normally analyzed as having a mora of their own (e.g. Hayes 1989). Thus, the first syllable of the inflected verbs could be counted as trimoraic, such as [pūōn.nēē], *to harvest* in IPFV. However, Broselow et al. (1997) state that if the first part of the geminate consonant shares the mora with the preceding vowel, the faithfulness of moraic structure is not violated. The authors use the MORAFAITH constraint which demands a faithful correspondence of the number of moras linked to a segment. The number of moras linked to an input segment (S_i) must correspond to the number of moras linked to the output segment (S_o) (see (186), where $S_i \Re S_o$ denotes a correspondence relationship between input and output segments). Thus, MORAFAITH does not count the sharing of the mora, only the number of the moras associated with a segment. The SYLLBIN constraint restricts the number of moras per syllable to two (187); this constraint in Samue is dominating. NOSHAREDMORA prohibits sharing the mora (188); in Samue, it is low ranked.

(186) MORAFAITH: if the number of moras linked to S_i = n, and $S_i \Re S_o$, then the number of moras linked to S_o = n (Broselow et al. 1997, their (28))

(187) SYLLBIN: syllable weight should not exceed two moras (Broselow et al. 1997, their (27a))

(188) NOSHAREDMORA: Moras should be linked to single segments (Broselow et al. 1997, their (27b))

If a geminate consonant is counted as moraic, the input for [pūōn.nēē] has three moras for the first syllable. The winning candidate will nevertheless have only two moras, of which the second one is shared with the first part of the geminate consonant. This is illustrated in (189). The losing candidates violate the MORAFAITH consonant, if the nasal is not counted as moraic (candidate ii.), or the SYLLBIN constraint, if the nasal has a mora for its own (candidate iii.). MORAFAITH and SYLLBIN both dominate NOSHAREDMORA constraint.

(189)

μ μ μ μ | | | /\ CV_1V_2 N V V /puonnee/	MORAFAITH	SYLLBIN	NOSHARED MORA
i. ☞ σ σ |\ /| μ μ μ | | /\ CV_1V_2N VV [puonnee]			*
ii. σ σ |\\ /| μ μ μ μ | | | /\ CV_1V_2N VV [puonnee]		*!	
iii. σ σ | \ /| μ μ μ | | /\ CV_1V_2N VV [puonnee]	*!		

6.3.2 Frequency and co-occurrence of consonant phonemes

The most frequent consonants in Samue are /n/ and /k/. However, /n/ is more frequent in a medial than in an initial position. The frequency of consonant phonemes as percentages is presented in Table 9. The count is based on the frequency in the wordlist, not the frequency in corpus texts. /ɾ/ is the only consonant phoneme that is not attested in a word initial position, whereas /f/ is almost solely employed in an initial position. Consonants are not allowed in a word final position.

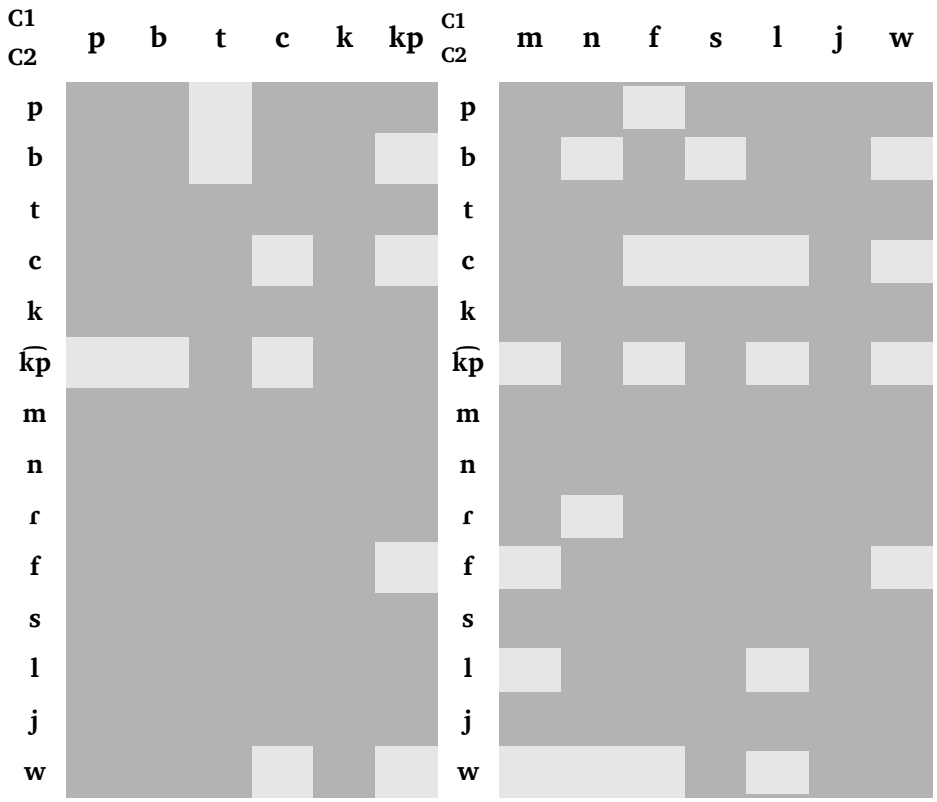
Table 9. Percentage of consonant phonemes in total, in initial and medial positions.

Consonant	Total	Initial	Medial
/p/	4,7	6,2	3,9
/b/	3,9	6,2	2,5
/m/	6,9	3,7	8,7
/f/	3,2	6,4	1,3
/t/	6,4	10,3	4,2
/n/	24,5	7,4	34,6
/s/	9,4	9,7	9,3
/r/	2,4	-	3,9

Consonant	Total	Initial	Medial
/l/	5,3	4,3	5,8
/c/	2,5	4,6	1,3
/j/	7,8	9,7	6,7
/k/	16,1	17,6	15,2
/kp/	2,3	4,5	1,1
/w/	4,5	9,3	1,6
Total	100%	100%	100%

The co-occurrence restrictions of consonants are few, if the first and the second syllable consonants are compared (see Table 10). /j/ and /k/ in position of C_1 (initial consonant) are the only consonants attested with all other consonants. Stops in position C_1 are employed with almost all other consonants, except for /kp/ and for /t/, which does not co-occur with /p/ and /b/. The nasal consonants in position C_2 (initial consonant of the 2nd syllable) are attested with all other consonants. The same holds true for /s/ and /j/. Among stops, /t/ and /k/ in position C_2 are combined with all other consonants. However, /kp/ has some restrictions, as /w/ also. The /w/ and /kp/ phonemes have more restrictions than other consonants in both C_1 and C_2 positions.

Table 10. Co-occurrence of consonants in position C_1 with consonants in position C_2. The light shading denotes combinations not attested. C_1 = x-axis, C_2 = y-axis.



6.3.3 Consonant sequences

Consonant clusters occurring across syllable boundaries are restricted in Samue; at least one of the consonants has to be a sonorant consonant. In careful speech, only the homorganic NC sequences are attested (nasal plus stop) (see more in 6.1.6). The other possible clusters are combinations of a stop followed by a lateral (190), or a nasal followed by a non-homorganic stop (191), or nasal (192) or a liquid followed by a nasal (193). When these words are pronounced carefully, the consonant cluster is separated by a vowel. Often the vowel between a stop and a lateral has a short duration (see also 6.4.4).

(190) Stop + liquid: /ì pīl-āā nā/ → [ì**pl**āānā] *he is sweeping (3s sweep-IPFV AFF)*
(191) Nasal + stop: /tùmùtáá/ → [tù**mt**áá] *errand*
(192) Nasal + nasal: /kɔ̀mì-ní/ → [kɔ̀**m-n**í] *to go to bed*
(193) Nasal + liquid: /nā̃pōɾō-nǐ/ → [nā̃pō**ɾ-n**ǐ] *guardian*

In a word initial position, only a stop + lateral sequence is attested as onset. This situation occurs when a vowel is deleted, except for one word, which has /kl/ in a word initial position: **klá**, *plant (sp)*. In a word initial position, a syllabic nasal is combined with a stop across morpheme boundaries, as was discussed in 6.1.6. Because the occurrence of stop + lateral sequence is very marginal, it is not analyzed in more detail.

6.3.4 Frequency of vowel phonemes

The vowel /a/ is the most frequent vowel in Samue, followed by /i/ and /u/. In other words, the mid-high and mid-low vowels are less frequent. Long vowels also are less frequent, as are the nasal vowels. The frequency of vowel phonemes in percentage is presented in Table 11. The count is based on the frequency in the wordlist, not the frequency in corpus texts.

Table 11. Frequency of vowel phonemes in percentage.

/i/	15,2	**/u/**	15,1	**/a/**	30,8
/ĩ/	1,7	**/ũ/**	1,5	**/ã/**	4,5
/ĩː/	0,2	**/ũː/**	0,1	**/ãː/**	0,9
/iː/	0,9	**/uː/**	0,7	**/aː/**	3
/e/	10,8	**/o/**	5,9		
/eː/	1,7	**/oː/**	0,5		
/ɛ/	2,2	**/ɔ/**	3,4		
/ɛː/	0,3	**/ɔː/**	0,4		

6.3.5 Vowel sequences

6.3.5.1 Data

Vowel sequences in Samue are restricted to sequences, where the first vowel is high and the second one is lower. In most cases, the sequences are [ie], [ia], [uo] and [ua], sometimes [uɔ] (see in (194)). The sequence [ue] is found in three words: **sàmúé** (*Samue language*), **námúé** (*meat, pl.*) and **súé** (*food*). Vowel sequence [uɛ] is attested only in one word, namely **púɛ́**, *somebody*. These words also contradict vowel harmony, which is discussed in 6.4.2

(194)

sìé	*tree*	**síà**	*big brother*
kūá	*calabash*	**kūó**	*anus*
púɔ́	*husband*		

Vowel sequences contrast with long vowels in nouns, although it is difficult to find minimal pairs, for example because of the tonal differences (195). Vowel sequences, as well as the long vowels, can bear the same tone or different tones. In some Gur languages, vowel sequences or diphthongs are analyzed as variants of long vowels (Naden 1989). In Kɔnni, that pattern is attested, as the mid vowels do not surface long, but have diphthongized equivalents (Cahill 2007a). In Samue, however, all mid vowels are attested long, as seen previously.

(195)

oo	**kóò-mŭ**	*owl-pl*		
uu – uo	**kúú-mú**	*head-pl*	**kūó-mú**	*anus-pl*
ɔɔ	**tɔ́ɔ̀-mă**	*group-pl*		
uu – uɔ	**túú-sé**	*liver-pl*	**túɔ̀-mă**	*wattle-pl*
ee	**fèè-mŭ**	*greeting-pl*		
ii – ie	**fíí-mú**	*donkey-pl*	**fiè-mŭ**	*mistake-pl*

Vowel sequences are attested in the first syllable of the stem of a noun or verb, or at a morpheme boundary between the stem and the noun class singular suffix when the word structure is CVV. Phonetically, CVV words with vowel sequence or with a long vowel have approximately the same duration. In addition, according to native speaker intuition, words like **pìé** and **kúá** have a long vowel like the words **káá** or **tàá**. Although, as previously stated, native speaker intuition is not always reliable. These CVV words are considered as monosyllabics having a diphthong,

which is taken into consideration in the analysis, although these diphthongs are often referred to as vowel sequences.

There is a question of interpretation concerning the words with vowel sequences. In Samue, vowel sequences are considered to be a combination of two vowels of different quality, instead of interpreting these sequences as a semivowel followed by a vowel. CVV-nouns with two different vowels have the noun stem CV and a V-suffix. For this reason the interpretation stating the phonological structure /k^{w}a/ or /kwa/ for [kūá] (*calabash*), and /s^{j}e/ or /sje/ for [sìé] (*tree*) is excluded. However, there is still a possible analysis between /kūá/ versus /kū.wá/, and /sìé/ versus /sì.jé/. Phonetically, there are words like [ɪ̀pìì-jě] (*darkness*) which clearly have the semivowel [j] as a syllable onset of the noun class suffix **-je** (see 3.1 for noun classes in Samue). There are also words, which phonetically do not have the semivowel, such as [pìé]-[pìè-mǔ] (*demand-s*). The contrast between /CVV/ and /CV(V)wV/ or /CVjV/ structures is found only in morpheme boundaries in nouns (stem + noun class suffix) (see (196)). The noun class suffix **-e** is a singular suffix, whereas **-je** is a plural suffix or used with the non-countable mass nouns. Because of the phonetic difference, the analysis of [súé] as /sú.jé/ is not plausible. The question is less clear with **-a** versus **-wa**, as they both are singular suffixes and the presence of [w] seems to arise if the stem vowel is a long back vowel, like in word /túúwá/, *bean*. However, there is a phonetic difference, as in [tú-à] the semivowel is not attested, and in [túú-wá] its presence is visible.

(196)

sg	**pl**	***Gloss***		**sg**	**pl**	***Gloss***
/súé/		*food*			/sú-jé/	*parents*
/wɪ̀-ā́/	/wɪ̀-bé/	*leaf*	**contrastive to**	/wɪ́ɪ́-já/		*rope*
/tú-à/	/túɔ̀-mǎ/	*wattle*		/túú-wá/	/túú-bá/	*bean*

The vowel sequences existing in the morpheme boundary in the singular do not occur in plural forms, because the plural noun class suffix is normally CV. Nor does the noun stem have the vowel sequence, because the stem is the same as in the plural form (see (197) and the noun-adjective complexes *big X* on the right side).

(197)

sg	**pl**	***Gloss***	**stem-*big*.sg**	**stem-*big*.pl**
tì-é	tìì-bě	*spot*	tì-kpě	tì-kpèmǔ
lúúp**í-é**	lúúpí-sé	*bird*	lúúpí-kpě	lúúpí-kpèmǔ
kpīf**ì-ā̀**	kpīfìì-mà	*rooster*	kpīfì-kpě	kpīfì-kpèmǔ
túúk**ú-á**	túúkú-má	*bee*	túúkú-kpě	túúkú-kpèmǔ
k**ū-á**	kūūmá	*calabash*	kū-kpě	kū-kpèmǔ
p**ú-à**	púú-mà	*thing*	pú-kpě	pú-kpèmǔ

The same phenomenon is found in monosyllabic verbs, which in the imperative are CV(V), and have the imperfective form by vowel suffix (see (198)). These sequences also occur across morpheme boundaries (verb stem + inflection).

(198)

IMP	**IPFV**	***Gloss***
kù	kū-ōō	*to cut*
pú	pū-ōō	*to urinate*
bū	bū-āā	*to remove*
fù	fū-āā	*to meet*
tū	tū-āā	*to (have a) wash*
pí	pī-ēē	*to demand*
nì	nī-āā	*to drink*

The first vowel of the vowel sequences is part of the lexical stem, and it becomes shorter in duration when combined with another vowel, but both vowels can bear distinctive tone and they are prosodically considered as moraic. Moreover, a phonetic difference exists across morpheme boundaries between the structures [CVjV] vs. [CVV], and [CVwC] vs. [CVV]. All these factors, as presented with the examples, reinforce the phonological analysis that the vowel sequences are vowel + vowel sequences, although phonetically the first vowel may be shorter and thus more glide-like. All types of vowel sequences are not attested in Samue. There are also restrictions on the morpheme types across which the vowel sequences are allowed; the sequences are allowed in the surface form only between noun stem and noun class suffix, or between verb stem and the inflectional suffix. The other cases will be examined with the morphophonological process of vowel coalescence (see 6.4.3).

However, there are a dozen words where the vowel sequences also exist in the plural form of nouns and also about fifteen verbs can be found (see (199)). In these type of words, a tentative analysis is to consider the first vowel as a semivowel. Nevertheless, both vowels are phonetically present in careful speech and sometimes both vowels also bear a different tone. In other words, it is not plausible to say that the consonant is labialized or palatalized, but rather that both vowels are moraic, as moras are important in the analysis of Tone-Bearing Units (e.g. Yip 2002, see also 7.1), and glides are analyzed as non-moraic in syllable theory (e.g. Hayes 1989). In this sense, the vowel sequences are diphthongs, which are bimoraic (e.g. Schane 1995).

(199)

Nouns

sg	**pl**	**X-big**	***Gloss***
kpíí-jé	kpíé-mú	kpíé-kpě	*man*
síé	síé-mú	síé-kpě	*care*
lìè-nǔ	lìè-mǔ	lìèŋm-kpě	*thirst*
kūó	kūō-mú	kūō-kpě	*anus*
púɔ́	púɔ́-jé	púɔ́-kpě	*husband*
púɔ́-já	púɔ́-jé	púɔ́-kpě	*mole*
Verbs			
IMP	**IPFV**		***Gloss***
púó	pūōnnēē		*to harvest*
tùò	tūōnnēē		*to burn/to char*
fíā́	fīānnēē		*to shell*

In some rare cases, a single vowel quality and a vowel sequence alternate in different grammatical forms, for example [ɛ] versus [ia], and [ɔ] versus [ua] (see examples in (200)). This phenomenon occurs in about 15 verbs between the imperative, where there is a vowel, and the imperfective, which has the vowel sequence. In nouns, the change is between singular and plural; singular has the vowel sequence in the morpheme boundary and the noun stem in the plural has a single vowel quality. In nouns, this pattern occurs very rarely, only in 5 nouns. The mid-low stem vowel [ɛ] and [ɔ] with the suffix **-a** in nouns and in verbs would create a non-permissible vowel sequences [ɛa] or [ɔa] in the language (see more in coalescence in 6.4.3). As a consequence, the mid-low vowel becomes high [i] or [u] preserving the feature [+ front].

(200)

sg	**pl**	***Gloss***
sí-à	sɛ́ɛ́-mà	*big brother*
fī-á	fɛ̄ɛ̄-má	*small brother*
sū-ā	sɔ̄ɔ̄-má	*recipient*
IPFV	**IMP**	***Gloss***
tī-āā	tɛ̄	*to crash*
lī-āā	lɛ́	*to deny*
fī-āā	fɛ́ɛ́	*to pass*
tū-āā-ní	tɔ̀-ní	*to sit down*

However, there are also a few cases with nouns, where the stem vowel seems to be assimilated completely into the vowel suffix -**a**, instead of maintaining the vowel sequence. Some examples are /bá-à/, *house*, versus /bɔ́ɔ̀-mǎ/, *houses*, and /já-á/, *year*, versus /jɛ́ɛ́-má/, *years*. Winkelmann (2007a) suggests that there may have been two different noun class suffixes: one consisting solely of a vowel, which led to the complete assimilation with the stem vowel, and another one consisting of CV syllable, which later on lost the consonant, and thus surfaces now as -**a** suffix. This would explain the different behavior of some nouns, such as /jáá/-/jɛ́ɛ́-má/, *year-years*, in comparison with /síà/-/sɛ́ɛ́-mà/, *big brother-big brothers*.

6.3.5.2 Analysis

Vowel sequences in Samue occur mainly across morpheme boundaries and both vowels are moraic forming a diphthong, as seen in the previous section. Several constraints are needed to account for the vowel sequences and their syllabification. A constraint is needed to account for the fact that underlying vowels, i.e. those that are moraic, are not supposed to become glides. A possibility is to use MAX-μ constraint, which demands a faithful correspondence of every input mora in the output (e.g. Itô, Kitagawa & Mester 1996). However, in the case of Samue, a simpler MAXV is sufficient to prohibit the deletion of a vowel.

Casali (1996) states in his study of vowel hiatus resolution, that languages use different strategies to avoid vowel hiatus, and also different strategies are used in the same language. One of these strategies is vowel coalescence, which will be discussed in section 6.4.3. Two other possible strategies exist when both vowels in morpheme boundaries are kept, namely heterosyllabification and diphthong formation. In Samue, according to the analysis adopted in the present study, the strategy of diphthong formation is especially employed, as seen with the examples of the previous section where the second vowel of the vowel sequence belongs to the same syllable as the first one. Casali (ibid.) posits that in this case, the NODIPH (205) constraint is violated.

Cahill (2007a) analyzes the diphthongization in Kɔnni and uses MAX[close] and DEP[close][14] in order to conserve the featural faithfulness of the high vowel of the vowel sequence. In this study, MAX[i,u] is preferred, as in (202). Featural faithfulness constraints such as IDENT[F] are not sufficient alone in this case, as the deletion or epenthesis of a segment (having a specific feature) does not necessary violate IDENT[F] constraint, if the features in question are not the same.

[14] Cahill (2007a) used vowel height features of multiple occurrences of [closed], rather than the more common [high] and [low].

The following constraints are used to analyze heterosyllabic vowel sequences in Samue:

(201) MAXV: assign a violation mark for every input vowel that does not have a correspondent in the output

(202) MAX[i,u]: assign a violation mark for every input [+high] vowel which does not have a correspondent in the output

(203) DEP(S): assign a violation mark for every segment which is epenthesized (as in (173))

(204) ONSET: assign a violation mark for every syllable not having an onset consonant (as in (174))

(205) NODIPHTHONG: assign a violation mark for every tautosyllabic diphthong (as in (184))

(206) IDENTV2: assign a violation mark for every input vowel V2 of the vowel sequence which does not have an identical correspondent in the output

The constraint ranking for the word /kū-á/, *calabash*, is illustrated in (207). MAXV preserves all the vowels of the word and thus prohibits glide formation and deletion of one of the vowel segments (candidates ii., v. and vi. in (207)). DEP(S) on the other hand does not allow epenthesis, such as candidate iii. ONSET prohibits vowel initial syllables. MAX[i,u] keeps the vowel of the first segment, as only the sequences with a high vowel followed by a lower vowel are allowed in Samue. To avoid vowel coalescence, i.e. that the vowel sequence would surface as a long vowel, IDENTV2 constraint is employed. It demands faithful correspondence of the second vowel between input and output (candidates vii. and ix.). If the long vowel is created with the second vowel quality only, it automatically violates the MAX[i,u] constraint (candidate viii.). These five constraints (MAXV, DEP(S), MAX[i,u], IDENTV2 and ONSET) all dominate NODIPH constraint. The winning candidate [kua] in (207) violates NODIPH with the syllable structure CVV, but not the other more dominating constraints. However, the ranking hierarchy between the other constraints is not established.

(207) The word /kū-á/, *calabash*, consisting of the stem plus the noun class suffix

/kū-á/	MAXV	DEP(S)	MAX[i,u]	IDENTV2	ONSET	NODIPH
i. ☞ [kua]						*
ii. [kwa]	*!					
iii. [ku.wa]		*!				
iv. [ku.a]					*!	
v. [ku]	*!					
vi. [ka]	*!		*!			
vii. [kuu]				*!		
viii. [kaa]			*!			
ix. [kɔɔ]			*!	*!		

A diphthong occurs only in some rare words in the stem-internal position. It is not plausible to analyze the stem-internal vowel sequence as belonging to two different syllables. The stem-internal diphthong is analyzed with the same constraints than the vowel sequences occurring between the stem and the suffix. Thus, the winning candidate [púɔ́-jé] in (208) violates NODIPH constraint, but the other candidates violate more highly ranked constraints, such as MAXV, DEP(S), MAX[i,u], IDENTV2 and ONSET.

(208) /púɔ́-jé/, *husbands*, in plural

/púɔ́-jé/	MAXV	DEP(S)	MAX[i,u]	IDENTV2	ONSET	NODIPH
i. ☞ [puɔ.je]						*
ii. [pu.ɔ.je]					*!	
iii. [pwɔ.je]	*!					
iv. [pu.je]	*!					
v. [puu.je]				*!		
vi. [pu.wɔ.je]		*!				

The same constraints as above are employed in the case of verbs which have an inflected form with a long vowel suffix, except for the fact that the *VVV constraint is needed to prohibit a tautosyllabic VVV structure (209). This is illustrated with the verb **kù**, *to cut* in imperfective: [kū.ōō] (210). The imperfective suffix must be kept long, consisting of two moras, because the short suffix refers to the future tense. The winning candidate [ku.oo] violates the ONSET constraint. The candidate [kuoo] illustrates that the *VVV constraint is more dominating than ONSET. Also, the following tableau proves the ranking between MAXV and DEP(S) in relation to ONSET; MaxV (candidate ii.) and DEP(S) (candidate v.) dominate the ONSET constraint. This ranking was not previously proved with nouns, because the noun suffix is a single vowel in the case of diphthongs.

(209) *VVV: assign a violation mark for every tautosyllabic VVV structure

(210) The verb /kù/, *to cut*, in imperfective [kūōō]

/kù-ōō/	MAXV	DEP(S)	MAX[i,u]	IDENTV2	*VVV	ONSET	NODIPH
i. ☞ [ku.oo]						*	
ii. [kwoo]	*!						
iii. [kuo]	*!						*
iv. [kuoo]					*!		
v. [ku.woo]		*!					
vi. [kuu]	*!			*!			
vii. [koo]	*!		*!				

The last vowel sequence type to be analyzed is the /síà – sɛ́ɛ́mă/, *big brother*, type of words, i.e. where the stem vowel changes between plural and singular. The restriction on vowel sequence types that needs to be taken into consideration is the fact that the first vowel must be high. Thus [ɛa] as a vowel sequence is prohibited. HIDIPH constraint demands diphthongs to have a high first vowel (see (211)), i.e. it prohibits any diphthong of a non-high vowel followed by another vowel quality, in the sense that Cahill (2007a) uses HIDIPH, which demands that a segment of the sequence is maximally [closed] in a tautosyllabic diphthong. In Samue, the first vowel of the stem stays front, which is accounted for by the MAX[front] constraint (212), and becomes [+high], although the faithfulness constraint IDENT[-high, -low] is violated (see (213)). There are thus three more constraints employed in the analysis of the word *big brother*.

(211) HIDIPH: assign a violation mark for every diphthong, where the first vowel is [-high]

(212) MAX[front]: assign a violation mark for every input vowel [+front] which is deleted in the output

(213) IDENT[-high, -low]: assign a violation mark for every input vowel [-high, -low] (i.e. a mid vowel) which does not have an identical correspondent in the output

The analysis of *big brother* is illustrated in (214). HIDIPH is higher ranked than IDENT[-high, -low]. The candidate [sia] is the winner, although it violates the low-ranked IDENT[-high, -low] constraint. The MAX[front] constraint has a stringency relationship with IDENT[-high, -low] constraint (see candidates i. and vi.).

(214) */sɛ́-à/, big brother,* which has the output form [síà]

/sɛ-a/	MAXV	HIDIPH	DEP(S)	MAX[front]	IDENTV2	IDENT[-high, -low]
i. ☞ [sia]						*
ii. [sɛ.wa]			*!			
iii. [sɛa]		*!				
iv. [sɛ]	*!					
v. [sɛɛ]					*!	
vi. [saa]				*!		*

6.3.6 Restrictions of consonant + vowel combinations

The restrictions of consonant and vowel combinations are quite few in Samue when examining simple verbs and nouns (stems + noun class suffix). All the stops can be followed by all the vowels, except for /kp/ which never precedes /u/. See the details in Table 12 (and the following Tables) where the cells shaded with a light grey are not attested; the number 1 or 2 marks the very rare combinations. An interesting phenomenon is that nasals are not attested in front of mid vowels (mid-high or mid-low) in the first syllable of the word, if the vowel is short (see Table 13). With a long vowel /ɔɔ/, the /n/ is attested in the first syllable, but /m/ is never allowed preceding any mid vowels. This might be an accidental gap, but that pattern appears in the Kwa languages of the Niger-Congo family quite frequently (Hyman 1972).

Table 12. Stops in the word initial position followed by the vowel.

	#_i*	#_e*	#_ɛ*	#_a*	#_ɔ*	#_o*	#_u*
p					1		
b							
t					1		
c		1	1				
k							
k͡p					1		

Table 13. Other consonants in the word initial position followed by the vowel.

	#_i*	#_e*	#_ɛ*	#_a*	#_ɔ*	#_o*	#_u*
m							
n							
f							
s			1				
j							
w			1				
l					1		

In a word medial position, in the second or third syllable, stops are attested with nearly all vowels (see Table 14). The /kp/ is allowed neither before /u/ nor /ɔ/ in this position. The palatal stop /c/ has also some restrictions that may be due to its low frequency of occurrence. In word medial position, nasals have the same restrictions as in the word initial position, and they are thus very rarely followed by mid vowels, if at all (see Table 15). However, the /n/ makes an exception before /e/; the /nnee/ sequence is very frequent in the nouns derived from verbs.

Table 14. Stops in word medial position combined with different vowel qualities.

	[V]_i	*[V]_e*	*[V]_ɛ*	*[V]_a*	*[V]_o*	*[V]_ɔ*	*[V]_u*
p							
b							
t		1					
c							
k							
k͡p							

Table 15. Other consonants in word medial position.

	[V]_i	*[V]_e*	*[V]_ɛ*	*[V]_a*	*[V]_ɔ*	*[V]_o*	*[V]_u*
m		1			1	2	
n					1	1	
f							
s							
j							
w	1		1				
l							
ɾ							

6.3.7 Section synthesis

The phonotactics of Samue follows largely the attested patterns in other Gur languages. The open CV(V) syllable structure is preferred in Samue, although the nasal is allowed in the coda position (CVN). Nouns show more variation in their word structure than verbs which are often mono- or disyllabic in their simplest imperative mood. Pronouns and grammatical words can be expressed by V or N structures only. Nasal consonant can be syllabic in Samue; otherwise the vowel is the syllable nucleus.

The syllable structure analysis reveals that ONSET and *CODA constraints can be violated in Samue, although onsetless syllables are restricted as well as the CODACONDITION constraint limits coda consonants. MAX(S), DEP(S) and *COMPLEX are all more dominating in Samue than ONSET and *CODA. The ranking of the constraints is illustrated by a Hasse diagram in Figure 18, where the top line indicates the unviolated constraints, and the arrows show which constraints the higher ranked constraint dominates[15]. The CODACONDITION constraint does not show any ranking relationship with other constraints. This is because it was used only with a few examples that showed a stringency relationship between CODACONDITION and *CODA, i.e. all the candidates that violate CODACONDITION will automatically also violate the *CODA constraint. The syllabification of nasal ending verbs, which take the **-nnee** suffix, were analyzed with *NNN and *N_{med} constraints. Those constraints are not included in the Figure below because of their rare use. However, it should be mentioned that *NNN would dominate MAX(S).

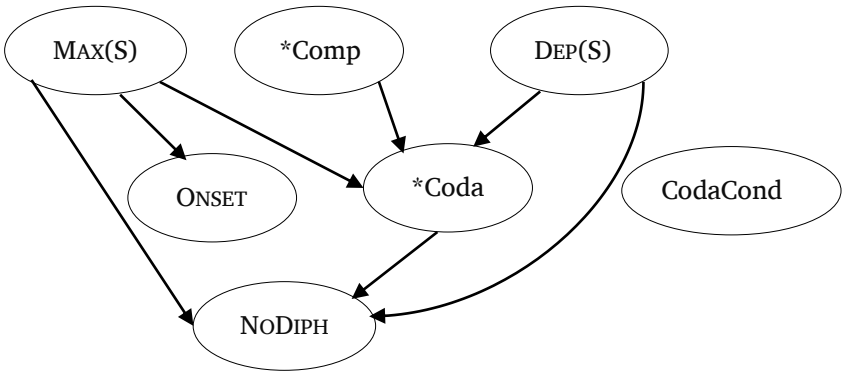


Figure 18. Hasse diagram of syllable structure constraints.

Consonant sequences are restricted in several ways. In careful speech, **only homorganic NC sequences are attested across syllable boundaries**. When the pronunciation is faster, CL, LN and non-homorganic NC or NN sequences are also attested. **Vowel sequences are restricted to**

[15] The Hasse diagrams (graphical representation of orders) were produced according to OTSoft software (Hayes, Tesar & Zuraw 2003).

sequences where the first vowel is high and the second one is a lower vowel. In Samue, vowel sequences occur mainly across morpheme boundaries and they are analyzed as plain vowels, not as semivowels. In many Niger-Congo languages, high vowels are subject to glide formation when combined with another vowel quality (e.g. Casali 1995c), but this pattern does not occur in Samue. In Gur languages, vowel sequences arise from different sources, such as diphthongization or the metathesis of CV suffixes (cf. Naden 1989). Naden (id.) suggest that vowel sequences were not necessarily inherited from the proto-languages, i.e. their occurrence is rather the result of phonetic and/or phonological changes.

The vowel sequence analysis illustrated the following ranking of the constraints presented by a Hasse diagram in Figure 19. NODIPHTHONG is violated, as ONSET in some specific cases. However, ONSET dominates NODIPHTHONG, and *VVV dominates both ONSET and NODIPHTHONG. The constraint ranking diagram is more complicated, when the constraints needed in the analysis of the words where the stem vowel changes between plural and singular are included. This is illustrated in Figure 20 below. HIDIPH dominates the faithfulness constraint of the IDENT[-high,-low], as the first vowel of the diphthong has to be a [+high] vowel. MAX[front] is in a stringency relationship with the constraint IDENT[-high,-low].

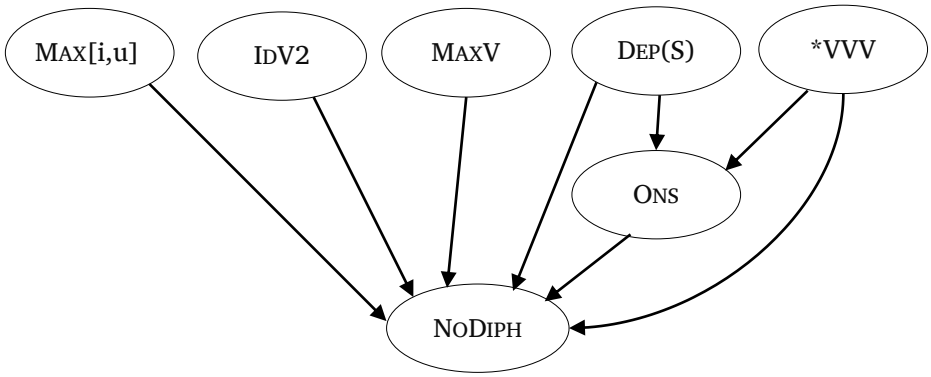


Figure 19. Hasse diagram of vowel sequence.

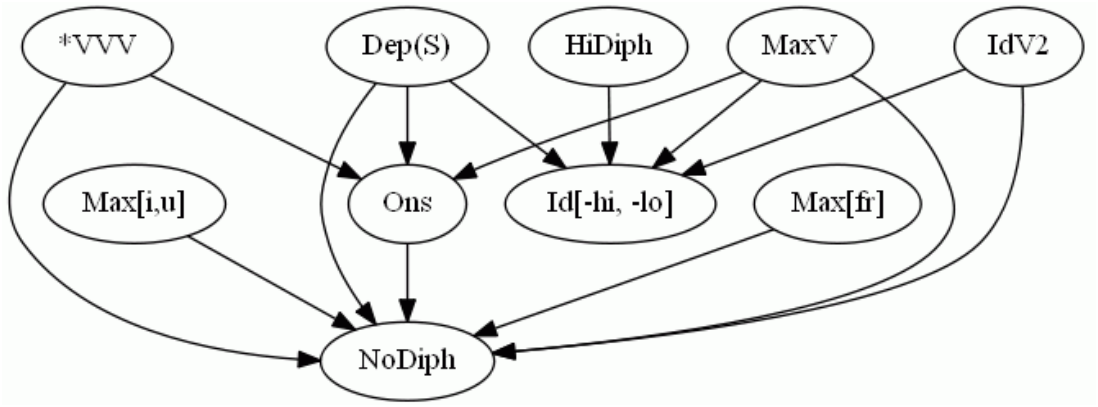


Figure 20. Hasse diagram of vowel sequences with analysis of the word where the stem vowel changes.

Restrictions of the combinations of consonants and vowels are very few in Samue. The labial-velar stop /kp/ is not attested in front of /u/. This is a cross-linguistic phenomenon, as often the labial-velars do not co-occur with high back vowels (Cahill 1999). A specific phenomenon in Samue is the fact that nasal consonants are attested very rarely or not at all in front of mid vowels, mid-high, and mid-low vowels.

6.4 Phonological processes

In this subsection the major phonological processes attested in Samue are described and analyzed. Consonantal assimilation is examined first, followed by a discussion on several processes concerning vowels, namely vowel harmony, vowel coalescence, vowel deletion, and vowel length variation.

6.4.1 Consonantal assimilation

6.4.1.1 Data

Consonants display assimilation of both place and manner of articulation. The place assimilation is attested especially with nasals followed by a stop, whereas the manner assimilation is found between nasals and other sonorants, but sometimes with stops as well. Voicing was already discussed in section 6.1.1.

The place assimilation is regressive, i.e. the place of the following stop affects the preceding nasal. This occurs stem-internally and at the morpheme boundaries. The examples given in (215)

illustrate how the 1st person singular pronoun /ǹ/ is realized in different places depending on the following consonant.

(215)

/ǹ báà/	→ [m̀báà]	*my house*
/ǹ cāāná/	→ [ɲ̀ɟāāná]	*my friend*
/ǹ kóó/	→ [ŋ̀góó]	*my head*

The lateral /l/ assimilates to [n] in direct contact with [n]. The approximant /w/ also displays manner assimilation when preceded by a nasal. In less careful articulation, the bilabial stop also assimilates to the preceding nasal. The manner assimilation is observed in the corpus mainly between a subject pronoun and the following verb, or in compound nouns. Some occurrences of alveolar stop assimilation also exist, but the velar stop does not assimilate to a nasal (see examples in (216)). Some nouns are also attested with a variable pronunciation, for example [ámmé] or [ámbé] for *mountain*. The deletion of /i/ of the 2nd person pronoun is discussed in section 6.4.4 on vowel deletion.

(216)

Phonologic	**Phonetic**	***Gloss***
/ń lāā nā/	[**ńn**āā nā]	*I go* (1s go(IPFV) AFF)
/tɔ̄n-lāá-ná/	[tɔ̄**nn**āáná]	*place* (sit-place-sg)
/ń báká nā/	[**ḿm**ágánā]	*I am tired* (1s be.tired(PFV) AFF)
/mì wónkúú nā/	[**m̀móŋg**úúnā]	*you have sowed* (2s sow(PFV) AFF)

The manner assimilation is progressive, and the examples also illustrate at the same time the regressive place assimilation. The manner assimilation displays the same characteristics as the stops in Samue in general. Stops in intervocalic position become voiced or weakened, and in contact with nasals, they assimilate to nasals, i.e. the process of lenition is attested in Samue in several ways.

6.4.1.2 Analysis

Place assimilation could be analyzed with the SPREAD(place) constraint as was illustrated previously in (85) according to Padgett (1995). However, because the SPREAD constraint defines a process, contrary to OT principles, rather than the state of inputs and outputs, the place assimilation is analyzed by AGREE constraints. Mascaró (2007) employed the AGREE(Consonant) constraint which requires complete assimilation of adjacent consonants. In the present study,

some more specific AGREE constraints are employed. The AGREE(C_{pl}) constraint prohibits two adjacent consonants that do not share place features (217). In nasal + stop sequences, the nasal is in coda position and the stop is the onset of the following syllable. The stop preserves its place feature; this is accounted for by the constraint IDENTONSETPLACE (IDENTONSPL) as in (219). The IDENTONSPL constraint dominates IDENT(place). This is illustrated below in (220) with the possessive pronoun /ǹ/ which is combined with the noun /báà/, *house*. The winning candidate [mbáà] violates the low-ranked IDENT(place) constraint, as the place of articulation of nasal changes, but not the more dominating constraints. The faithful losing candidate [ǹbáà], however, violates the AGREE(C_{pl}) constraint which dominates IDENT(place). The faithfulness constraint MAX(S) is highly dominant in Samue, and thus would prohibit the deletion of segments. For this reason it is not included in the following tableaux.

(217) AGREE(C_{pl}): assign a violation mark for two adjacent consonants that do not share the same place features

(218) IDENT(place): assign a violation mark for every place of articulation in the input which does not have an identical correspondent in the output

(219) IDENTONSPL: assign a violation mark for every onset consonant in the input that has a different place in the output

(220) IDENTONSPL, AGREE(C_{pl}) » IDENT(place)

/ǹ-báà/	IDENTONSPL	AGREE(C_{pl})	IDENT(place)
i. ☞ [**m̀b**áà]			*
ii. [**ǹb**áà]		*!	
iii. [**ǹd**áà]	*!		*

The same constraints explain also the place assimilation stem-internally in NC-sequences, as illustrated with the word /kpɛ̄nkpâ/, *gall bladder*, in (221). The voicing agreement was analyzed already in section 6.1.1.2.

(221) IDENTONSPL, AGREE(C_{pl}) » IDENT(place)

/kpɛ̄nkpâ/	IDENTONSPL	AGREE(C_{pl})	IDENT(place)
i. ☞ [kpɛ̄**ŋ͡mg͡b**à]			*
ii. [kpɛ̄**ng͡b**à]		*!	
iii. [kpɛ̄**nd**à]	*!*		**
iv. [kpɛ̄**ŋŋ**à]	*!*		***

The constraints needed for the manner assimilation analysis are basically the same as those for place assimilation, but instead of place, a manner feature is needed. A specific AGREE[nas]

constraint is employed to account for the nasal assimilation. This is illustrated with the word /tɔ̄n-lāá-ná/, *place.* The winning candidate [tɔ̄nnāáná] does not satisfy the faithfulness constraint of the manner of assimilation, as in (225). However, faithfulness to the nasal feature and the agreement of nasal feature are higher ranked. Thus, the faithful [tɔ̄nlāáná] is a loser, as it violates AGREE[nas]. In (225), the assimilation of an approximant and of a stop to nasal is also illustrated (examples b) and c)).

(222) AGREE[nas]: assign a violation mark for two adjacent consonants that do not share the manner feature [nasal]

(223) IDENT(manner): assign a violation mark for every manner of articulation in the input which does not have an identical correspondent in the output

(224) MAX[nas]: assign a violation mark for every nasal consonant which is deleted in the output

(225) MAX[nas], AGREE[nas] » IDENT(manner)

a) /tɔ̄n-lāá-ná/	MAX[nas]	AGREE[nas]	IDENT(manner)
i. ☞ [tɔ̄**nn**āáná]			*
ii. [tɔ̄**nl**āáná]		*!	
iii. [tɔ̄**ll**āáná]	*!		*
b) /mì wónkúú nā/ *you have sowned*	MAX[nas]	AGREE[nas]	IDENT(manner)
i. ☞ [**m̀m**óŋgúúnā]			*
ii. [**m̀w**óŋgúúnā]		*!	
iii. [**ẁw**óŋgúúnā]	*!		*
c) /ń báká nā/ *I am tired*	MAX[nas]	AGREE[nas]	IDENT(manner)
i. ☞ [**ḿm**ágánā]			*
ii. [**ḿb**ágánā]		*!	
iii. [**bb**ágánā]	*!		*

The problem with the previous analysis is that there is the same input in (220) and (225), but the actual output is different in these two cases, i.e. /nb/ results either [mb] with the place assimilation, or [mm] with both place and manner assimilation. The data in the corpus do not illustrate both place and manner assimilations between possessive pronoun and the following noun. Thus the input /nb/ has the output [mb] in that case. Total assimilation is attested only between the subject pronoun and the following verb or in some compound nouns. Consequently, if the syntax-phonology interface is adopted, the AGREE[nas] constraint should be specified for

the syntactic categories between the subject pronoun and the following verb. However, this posssible case of a syntax-phonology interface needs a more detailed analysis in the future with some additional data.

6.4.2 Vowel harmony

6.4.2.1 Data

Vowel harmony is attested in Samue within two features: [ATR] and [back]. The featural system of the vowels in Samue is presented in (226) where it is possible to see the [back] vowels /u/, /o/ and /ɔ/ and the different [ATR] values. Approaches to analyzing **ATR harmony** were discussed in section 5.3.2.3.

(226)

			[front]	[back]
[-low]	[+high]	[+ATR]	i	u
	[-high]		e	o
		[-ATR]	ɛ	ɔ
[+low]			a	

In Samue, the [-ATR] vowels /ɛ/ and /ɔ/ do not co-occur in the simple stems with the [+ATR] vowels /i/, /e/, /u/ and /o/. In compound or loan words, vowel harmony is not respected. The central low vowel /a/ is neutral in Samue, and it is featurally unspecified for [ATR]. This means that only the mid vowels in Samue are specified separately for [ATR] feature: /e/ and /o/ are [+ATR] and /ɛ/ and /ɔ/ are [-ATR]. The neutrality of /a/ is seen, for instance, with the noun class suffix **-na/-ma** which can be combined with all stem vowels. /a/ is also attested in bi- or trisyllabic stems with [+ATR] vowels, but with mid vowels only if the /a/ is in the position V_1. However, there are no simple stems, where /a/ is attested with /ɔ/. With high vowels, /a/ may occur in V_1 and V_2 positions. See examples of the neutral position of vowel /a/ in (227).

(227)

Noun class suffix -na or -ja

jìmì-nă	*moon*	**kùnù-mă**	*dead-pl*
lèkè-já	*hunter (verbal stem)*	**lòfáá-ná**	*straw hat (sp)*
kɛ̂n-nă	*bambara nut*	**fɔ́gɔ̀-nă**	*basin*
bàbà-nă	*rice field furrow*		

(227)

Stems with /a/			
mání	*to talk*	**púúmá**	*to live*
sə̀sé-nú	*needle*	**kàlōò-nă**	*carp (sp)*
làkɛ̀	*to swear*		

In Samue, the ATR harmony is sometimes also attested in suffixes, for example, the noun class **-nu/-mu** and the plural suffix **-s**e are never attached to stems which have [-ATR] vowel qualities, as illustrated in (228), but the neutral vowel /a/ can be part of those stems. The **-se** suffix is also attested with words containing only the neutral vowel /a/ in the stem. Accordingly, the stems which contain only mid-high vowel /e/ or /o/, respectively, will have a suffix which is also [+ATR]. Namely /o/-stems are attested with the suffixes **-nu/-mu** and **-se**, and /e/-stems with suffixes **-nu/-mu**. The noun suffixes **-nu/-mu** do not have a [-ATR] counterpart; they cannot be analyzed as an [+ATR] alternative for **-na/-ma** suffixes, because both **-nu/-mu** and **-na/-ma** can be attached to [+ATR] stems, as illustrated above in (227). Nevertheless, the rare noun suffix **-ni** with the vowel /i/ is attested also with [-ATR] stems, because the **-ni** refers to human agents. It is used with words formed for example from verbs or adverbs, like the word **sɔ̄lɔ̄-nǐ**, *the last one*, from the adverb **sɔ̄lɔ̄**, *later*. With **-ni** suffix, thus, vowels do not harmonize between the stem and the suffix.

(228)

[+ATR]		**[-ATR]**	
cìisě-mŭ	*insult-pl*	**tɛ́ntɛ̄ɛ̄-má**	*grasshopper-pl*
nú-mú	*water-pl*	**lɛ̀ntɛ́-má**	*basket-pl*
kpèlé-mú	*stick-pl*	**sɔ̀nsɔ̀kɔ̀-mă**	*bird-pl (sp)*
bə́fɛ́ɛ́-mú	*type of hat-pl*	**bɔ̀nkɔ̀-má**	*gecko-pl (sp)*
bákájé-mú	*tiredness-pl*		
Invariable -se suffix			
bóókó-sé	*village-pl*	**kpə̄ə̄-sé**	*iguana-pl*
kúló-sé	*hunger-pl*	**táká-sě**	*wound-pl*

The plural suffix **-bE** displays vowel harmony, because it is realized **-be** with [+ATR] stems and **-bɛ** with [-ATR] stems, as illustrated in (229). With the neutral vowel /a/, the suffix is realized as [-ATR] [bɛ]. The hypothesis is that the suffix **-bE** is underlyingly /bɛ/, and it harmonizes in [+ATR] context. This hypothesis is adopted, because with the neutral stem vowel /a/, **-bE** suffix is realized [bɛ]. However, there are two exceptional words, which have the stem vowel /u/ combined with suffix vowel /ɛ/: **pù-bɛ̌**, *hole-s*, and **lú-bɛ́**, *pus*. In these words the normal [ATR]

pattern is not respected. This may be due to some sort of neutrality of high vowels that has sometimes been observed in the 7-vowel system harmonies (e.g. Casali 2008). Two frequently used words display the same kind of disharmony, namely **cíī-bɛ̌**, *woman*, and **lɛ́mí-á**, *tongue*. However, these few irregular patterns are not analyzed in more detail in this study.

(229)

[+ATR]		[-ATR]	
sìì-bě	*tree-pl*	**kɛ́ɾɛ̀-bɛ̌**	*bambara nut-pl*
tìì-bě	*spot-pl*	**tɔ́kɔ̀-bɛ̌**	*yam-pl*
wùsù-bě	*dust-pl*	**fāɾā-bɛ̌**	*shoe-pl (sp)*
kúsù-bě	*egg-pl*	**bàɾà-bɛ̌**	*bat-pl (sp)*

The [back] harmony is best illustrated with disyllabic verbs, in which the front and back vowels are not mixed in the imperative mood. As a consequence, the [-ATR] vowels /ɛ/ and /ɔ/ are not combined in the same simple lexeme (see (230) for examples).

(230) Verbs in IMP

Front vowels		Back vowels	
pīlī	*sweep*	**tūlū**	*dare*
kpìnì	*last*	**wű́sō**	*get up*
jìlè	*enter*	**wúló**	*bite*
fējī	*comb*	**kòmù**	*miss*
cééké	*watch*	**tóókó**	*send*
kpēɾé	*poison*	**wɔ̀lɔ̀**	*sleep*
		k͡pásá	*run away*

Among the 203 disyllabic verbs, there are only five exceptions to this [back] harmony pattern in the imperative. The imperative forms **cōmī** (*sieve with a basket*), **tūmī** (*castrate*), **kɔ́míní** (*go to bed*), **cɔ́mí** (*stab*) and **mūnī** (*harvest*) have a back vowel combined with /i/. The verb **cɔ́mí** (*stab*) has a consonant ending stem (cf. IPFV **cɔ̄m-āā**), which takes the imperative suffix **-i** contrary to vowel harmony, whereas **mūnī** (*harvest*) belongs to the verb class 3) with **-nnee** suffix (cf. IPFV **mūnnēē**). In the case of the verbs **cōmī**, **tūmī** and **kɔ́míní** the vowel **i** is included in all verb forms, i.e. not only in the imperative. However, the vowel /i/ is not always pronounced in **kɔ́míní** (*go to bed*), as the vowel may be deleted between two nasals in Samue (see 6.4.4). The vowel /i/ might thus be an epenthetic vowel in the verb **kɔ́míní**. However, this analysis does explain with difficulties the verb forms of **cōmī** (*castrate*) and **tūmī** (*sieve with a basket*). As was previously stated, close vowels may form disharmonic patterns that are accepted in the language.

Back harmony is also attested in verb class 2), where the IPFV form is done by vowel addition as previously illustrated in 3.4.1.2. Verbs stems that belong to this verb class end in vowels /i/

or /u/; verbs ending with other vowels have lengthened vowel in IPFV. If the stem has a /i/, the added vowel may be /e/ or /a/, whereas if the stem vowel is the back /u/, the added vowel is /o/ or /a/ (see (231)). The neutral /a/ can thus be added to both back and front stems.

(231)

IMP	**IPFV**	*Gloss*
fíí	**fī-ēē**	*find*
lí	**lī-ēē**	*kill*
pù	**pū-ōō**	*bury*
fùù	**fū-āā**	*meet*
bū	**bū-āā**	*remove*
nì	**nī-āā**	*drink*

In other inflectional forms of the verbs, vowel harmony is not respected. For instance, the IPFV syllable suffix **-see/-nnee** is attached to any verbs despite of their vowel quality. In nouns, the [back] harmony is mostly respected, but only stem-internally (232). Compound words and noun class suffixes do not conform to the [back] feature harmony, neither do the derivational words (see examples in (233)).

(232)

jírì-mǔ	*hair-pl*	**súmú-sé**	*heart-pl*
sɨ̀sè-mǔ	*shame-pl*	**wúló-mú**	*breast-pl*
bèlè-mǔ	*sacrifice-pl*	**bóókò-sě**	*village-pl*
lèntɛ́-má	*basket-pl*	**kɔ́kɔ̀-bɛ̌**	*plant-pl (sp)*

(233)

tɨ̀mù	*to cultivate*	**tɨ̀mù-sě**	*agriculture*
cō-jī	*to pour out*	**cō-jēē-ná**	*pouring*
kà-fɔ̀kà	*thing-white*	**ní-fɔ́ká**	*person-white*
kúsǔ, fɛ́ɛ́	*pregnancy, to take out*	**kúsù-fɛ̀ɛ́**	*abortion*

6.4.2.2 Analysis

The ATR harmony is analyzed first, followed by the back harmony discussion. In Samue, the ATR harmony does not spread across simple word boundaries. As all the inflectional syllables in verb morphology are always [+ATR], and no harmony is attested. The ATR harmony thus concerns the stems mainly, and in some contexts also the noun class suffixes. According to

Casali's (2003) analysis of the 7-vowel systems, the [-ATR] dominance is more often attested, at least the weak assimilatory [-ATR] dominance and the [-ATR] dominance in vowel coalescence, where the presence of one [-ATR] vowel will result in a fused [-ATR] vowel. This is the same in Samue and will be discussed in 6.4.3. With weak assimilatory [-ATR] dominance, Casali (ibid.) refers to an affix which will harmonize for the feature [ATR] in some contexts, but not in all. In the case where the harmony is not applied, the affix will have the [+ATR] form. The author cites examples of the Niger-Congo languages where such patterns are attested.

In Samue, it would be possible to postulate that the noun suffix -**se** displays the weak assimilatory [-ATR] dominance, as this suffix is attested only with [+ATR] roots and with neutral /a/-roots, but with /a/-stems the harmony is not applied. Nevertheless, the harmonizing (or recessive) suffix -**bE**, which is phonologically analyzed as /bɛ/, is realized as [bɛ] with /a/-stems and [-ATR] roots, but as [be] with [+ATR] roots, as illustrated in (229).

As presented in 5.3.2, vowel harmony may be analyzed with different types of constraints depending on the harmony system the language displays. The basic AGREE[ATR], MAX and DEP constraints for [ATR] are widely used in general vowel harmony presentations (e.g. Bakovic 2000) or in language specific analyses (e.g. Cahill 2007a). To faithfully maintain the root or the suffix ATR value, the constraints IDENT-ROOT[ATR] and IDENT-SUFFIX[ATR] are employed (e.g. Noske 2000). In Samue, ATR harmony does not spread across words, for example in compound nouns. However, a noun class suffix harmonizes to the [ATR] value of the root. Additionally, some noun class suffixes which are [+ATR] attach only to [+ATR] stems. To account for these processes, the following constraints are employed:

(234) AGREE[ATR]$_{noun}$: assign a violation mark every time that vowels in a noun do not agree in ATR between the stem and the suffix

(235) IDENT[ATR]$_{stem}$: assign a violation mark for every input vowel of the stem that differs in its [ATR] value in the output

(236) DEP[-ATR]: assign a violation mark for every [-ATR] occurrence in the output which does not have a correspondent in the input

(237) MAX[-ATR]: assign a violation mark for every [-ATR] occurrence in the input which does not have a correspondent in the output

(238) AGREE[ATR]: assign a violation mark every time that vowels in a word do not agree in ATR

AGREE[ATR]$_{noun}$ demands the ATR harmony to apply for stems and suffixes in nouns. IDENT[ATR]$_{stem}$ prohibits the change of [ATR] value within the stem. DEP[-ATR] and MAX[-ATR] are the basic faithfulness constraints for [-ATR]. In the following analysis of Samue, the neutral vowel /a/ is analyzed to agree in all contexts (i.e. it never violates AGREE[ATR]$_{noun}$). The

words which take the suffix with the neutral vowel /a/ are not analyzed with details, as the faithful candidates always win, because the neutral vowel does not violate [ATR] constraints.

The noun suffix -**bE** is phonologically /bɛ/. When it attached to [+ATR] roots, as illustrated in (239) with the word /kúsù-bɛ̌/, *egg-pl*, the suffix harmonizes to the root, and thus the winning candidate [kusu-be] violates MAX[-ATR]. It is shown in (239) that AGREE[ATR]$_{noun}$ dominates MAX[-ATR] in Samue. For this reason in the following tableaux, the MAX[-ATR] is separated by the solid line from the other constraints, although all the examples below do not prove that ranking. The completely faithful candidate [kusu-bɛ] violates the more highly ranked constraint AGREE[ATR]$_{noun}$, and thus, it is a loser. If the stem [ATR] value changes, the candidates are satisfying fewer constraints, and they are therefore easily out-ranked. With [-ATR] roots, the suffix /bE/ stays [-ATR], as illustrated in (240) with the word /kɛ́rɛ̀-bɛ̌/, *bambara nut-pl*. The faithful candidate satisfies all the constraints. However, the less faithful candidates violate several constraints, either AGREE[ATR]$_{noun}$ or IDENT[ATR]$_{stem}$ and DEP[-ATR] constraints. The ranking between IDENT[ATR]$_{stem}$ and DEP[-ATR] constraints stays unresolved.

(239)

/kusu-bɛ/	IDENT[ATR]$_{stem}$	DEP[-ATR]	AGREE[ATR]$_{noun}$	MAX[-ATR]
i. ☞ [kusu-be]				*
ii. [kusu-bɛ]			*!	
iii. [kʊsʊ-bɛ]	*!*	*!*		
iv. [kʊsʊ-be]	*!*	*!*	*!	*

(240)

/kɛrɛ-bɛ/	IDENT[ATR]$_{stem}$	DEP[-ATR]	AGREE[ATR]$_{noun}$	MAX[-ATR]
i. ☞ [kɛrɛ-bɛ]				
ii. [kɛrɛ-be]			*!	*
iii. [kere-be]	*!*			***
iv. [kere-bɛ]	*!*		*!	**

With the neutral vowel /a/, the -**bE** suffix is [-ATR]. This reinforces one of the following two hypothesis, either that the -**bE** suffix is underlyingly [-ATR], and for that reason it is realized [bɛ] with the neutral vowel /a/, either the neutral vowel /a/ is underlyingly [-ATR]. Because the neutral vowel /a/ is attested both in stems and in suffixes with both [-ATR] and [+ATR] vowels, the analysis that /a/ is unspecified for [ATR] is applied in the present study, and the -**bE** suffix is considered underlyingly [-ATR]. The word /bàrà-bɛ̌/, *bat-pl*, in (241) is an example of the latter, i.e. -**bE** is undelyingly [-ATR].

(241)

/baɾa-bɛ/	IDENT[ATR]$_{stem}$	DEP[-ATR]	AGREE[ATR]$_{noun}$	MAX[-ATR]
i. ☞ [baɾa-bɛ]				
ii. [baɾa-be]				*
iii. [bəɾə-be]	*!*			*

In (242), the faithful [+ATR] candidate [bèlè-mǔ], *sacrifice-pl*, will win, because it does not violate any constraints. The hypothetical candidates where the [ATR] value of the stem or of the suffix will change are out-ranked. The [+ATR] suffixes **-nu/-mu** are never attested with [-ATR] stems.

(242)

/bele-mu/	IDENT[ATR]$_{stem}$	DEP[-ATR]	AGREE[ATR]$_{noun}$	MAX[-ATR]
i. ☞ [bele-mu]				
ii. [bɛlɛ-mu]	*!*	*!*	*!	
iii. [bɛlɛ-mʊ]	*!*	*!**		
iv. [bele-mʊ]		*!	*!	

The **-se** suffix displays a different pattern, as it is always [+ATR], whether with [+ATR] stems or with the neutral vowel /a/. Nevertheless, it is not attached to [-ATR] stems. In the case of **-se**, the [ATR] harmony is not applied. The word /sa̋a̋-sé/, *stalk-pl*, illustrates this phenomenon in (243). However, it does not change the general ranking of the constraints used in the analysis of [ATR] harmony in Samue.

(243)

/sãã-se/	IDENT$_{stem}$ [ATR]	DEP[-ATR]	AGREE[ATR]$_{noun}$	MAX[-ATR]
i. ☞ [sãã-se]				
ii. [sãã-sɛ]		*!		
iii. [sə̃ə̃-se]	*!*			

Tableau (239) above proves the ranking argument for the following hierarchy in Samue: AGREE[ATR] » MAX[-ATR]. Nevertheless, the examples do not clearly state whether IDENT[ATR]$_{stem}$ or DEP[-ATR] dominates MAX[-ATR], because in most cases both IDENT[ATR]$_{stem}$ and DEP[-ATR] are violated for the same losing candidates, if the winning candidate violates MAX[-ATR].

In the case of verb inflection, the ATR harmony is not attested, thus for example the verb **kpɛ̄rɛ́**, *to poison*, in IPFV is [kpɛ̀rɛ́nnɛ̄ɛ̄]. The winning candidate [kpɛ̀rɛ́nnɛ̄ɛ̄] violates AGREE[ATR]. Thus, the constraint AGREE[ATR] is lower ranked than IDENT[ATR]$_{stem}$ and also DEP[-ATR] and MAX[-ATR]. This is illustrated in (244) below. This means, that the constraint ranking in Samue [ATR] harmony must be specified for nouns, as illustrated with the constraint AGREE[ATR]$_{noun}$ above, and thus the AGREE[ATR] is lower ranked in the language than AGREE[ATR]$_{noun}$. The ranking argument between IDENT[ATR]$_{stem}$, DEP[-ATR] and MAX[-ATR] constraints is not proved with the example in (244). The ranking hierarchy between IDENT[ATR]$_{stem}$ and MAX[-ATR] stays unresolved.

(244)

/kpɛrɛ-nnee/	IDENT[ATR]$_{stem}$	DEP[-ATR]	MAX[-ATR]	AGREE[ATR]
i. ☞ [kpɛrɛnnee]				*
ii. [kpɛrɛnnɛɛ]		*!*		
iii. [kpɛrennee]	*!*		*!*	

The [back] harmony prohibits front and back vowels from occuring in the same stem. The *DISAGREE[back] constraint as in (246) is employed to prohibit opposite [back] values in a word. The winning candidate [wulo] for the word /wúló/, *to bite*, satisfies both IDENT[back] (245) and *DISAGREE[back], whereas the unfaithful candidate [wule] violates both IDENT[back] and *DISAGREE [back].

(245) IDENT[back]: assign a violation mark for every instance of [back] value that does not have identical correspondent in the input

(246) *DISAGREE[back]: assign a violation mark for every instance of opposite [back] value in stem vowels or between stem and suffix vowels

(247)

/wúló/	*DISAGREE[back]	IDENT[back]
i. ☞ [wulo]		
ii. [wule]	*!	*

When the monosyllabic verb belongs to the verb class 2) which forms the IPFV by vowel addition, the added vowel is either the neutral vowel /a/ or the vowel conforms to back harmony. However, it is not possible to postulate, which vowel is underlyingly attached to the verb stem, because the neutral vowel /a/ is attested with both /i-/ and /u-/ stems, i.e. some stems choose a mid vowel while others choose a low vowel. If the underlying vowel is posited as /e/, then the

*DISAGREE[back] constraint forces it to become [+back] with a [+back] stem, as illustrated in (248) with example b) [puoo] (*to bury* in IPFV). The winning candidate [liee] (*to kill* in IPFV) do not violate neither *DISAGREE[back] nor IDENT[back] constraints; see a) in (248). The example with [puoo] proves the ranking hierarchy *DISAGREE[back] » IDENT[back].

(248)

a) /li-ee/	*DISAGREE[back]	IDENT[back]
i. ☞ [li-ee]		
ii. [li-oo]	*!	*
b) /pu-ee/	*DISAGREE[back]	IDENT[back]
i. ☞ [pu-oo]		*
ii. [pu-ee]	*!	

The above analysis does not give specific predictions about an additional neutral vowel, as illustrated with the verb [niaa], *to drink* in IPFV, in (249). The central neutral vowel can be freely added to stems containing any vowel, and thus it does not violate the *DISAGREE[back] constraint.

(249)

c) /ni-aa/	*DISAGREE[back]	IDENT[back]
i. ☞ [ni-aa]		
ii. [na-aa]		*!

This analysis of [back] vowel harmony is somewhat incomplete. The given examples prove constraint hierarchy *DISAGREE[back] » IDENT[back] only when the suffix vowel is a mid vowel, as the choice between a mid or a low suffix vowel seems to be lexically conditioned. The few exceptional disharmonic verbs cannot be analyzed with these two constraints, as it would predict an opposite ranking hierarchy between *DISAGREE[back] and IDENT[back], as illustrated in (250). Naden (1989) states that marked feature combinations, such as spreading of a [back] feature, are rare in Gur. However, in Samue the feature [back] seems to spread, at least when the verbal suffix is a vowel.

(250) Prediction of a wrong winning candidate i., indicated by a sad face, ☹.

/cómí/	*DISAGREE[back]	IDENT[back]
i. ☞ ☹ [comu]		*
ii. [comi]	*!	

6.4.3 Vowel coalescence

6.4.3.1 Data

As stated previously in 6.3.5, vowel sequences are allowed in Samue between noun or verb stems and the following suffix (noun class suffix or inflectional suffix). In some other contexts, the hiatus resolution is done by vowel coalescence, as can be illustrated in Samue between the noun and the following pronoun and the verb and the following object pronoun.

Nouns in the object position of an imperfective sentence and in the subject position of a perfective sentence, and nouns in postpositional or presentational phrases are followed by a reminder pronoun (see more in 3.1). The pronoun, or definiteness marker, in these cases is always a unique high vowel /i/ (subject pronoun) or /u/ (object pronoun) for humans and /u/ for non-humans. The nouns always end in a vowel. In the object position in an imperfective phrase and in the presentational phrases, the plural nouns with human reference also have a single vowel pronoun /u/; the other cases concern only singular pronouns. In consequence, there is a hiatus situation that emerges. In these cases the hiatus resolution is done by vowel coalescence. The coalescence is an automatic process occurring always in these specific cases, especially in naturally spoken sentences, i.e. that are not pronounced with extreme care.

With /u/ (non-human singular), the coalescence occurs in such a manner that the front vowels /e/ and /ɛ/ become back [oo] and [ɔɔ], respectively. The vowel /a/ becomes [ɔɔ]. The back vowel [o] is lengthened to [oo]. There are no nouns ending by /ɔ/. Thus, the vowel quality of the last vowel of the noun becomes back and slightly more closed because of the influence of the high back vowel /u/ (see examples in (251)). The vowel /i/ occurs with nouns having the human reference, and the hiatus situation emerges also in associative noun phrases (see more in 3.2). The human reference nouns can end by /e/, /ɛ/ or /a/ (see more in noun classes in 3.1). The /i/ ending nouns refer also to humans, but they do not represent a case of vowel coalescence, i.e. /i/ + /i/ → [ii]. The /a/ becomes [ɛɛ] in contact with the following /i/. The mid vowels /e/ and /ɛ/ become long, but their quality does not change. All possible vowel coalescence cases that emerge in nouns in Samue are schematized in (252); all [-ATR] vowels keep their [ATR] value.

(251)

Morphologically	**Phonetically**	***Gloss***
sì-é **ú tú** (tree-sg DEF below)	[sìòō tū]	*Under the tree*
Pű-bɛ́ tíí **npɛ́ɛ́ ú** sí. (quill-pl 3 PRES DEF in)	[pűbɛ́ tíí npɔ́ɔ̄ sí]	*There are three quills in it.*
Sì-ē ù lánmí nā. (tree-SG 3s.NH be.long(PFV) AFF	[sì**ōō** lánmí nā]	*The tree is big.*

Morphologically	**Phonetically**	***Gloss***
Ńtì pís-**é ú** cēē-kēē nā. (1s child-pl 3p.DO watch-IPFV AFF)	[ńtì pís**óó** cēēkēē nā]	*I watch the children*
kpíí-j**é í** pílbé (man-sg AM child)	[kpííjéé pílbé]	*The man's child*
sí-**à í** pílbé (big.brother-sg AM child)	[síèè pílbé]	*The big brother's child*
cíī-b**ɛ̀ í** pílbé (woman-sg AM child)	[cíībɛ̀ɛ́ pílbé]	*The woman's child*

(252)

Vowel coalescence	Noun + sNH	***Gloss***
V+u		
e+u → **oo**	sìé ù → **sìōō**	*tree + sNH*
ɛ+u → **ɔɔ**	npɛ́ɛ́ ù → **npɔ́ɔ̀**	*PRES + sNH*
u+u → **uu**	pùùnǔ ù → **pùùnūū**	*goat + sNH*
o+u → **oo**	jìnpǒ ù → **jìnpōō**	*fish + sNH*
a+u → **ɔɔ**	cìnă ù → **cìnɔ̄ɔ̄**	*wood + sNH*
V+i		
e+i → **ee**	kpííjé í → **kpííjéé**	*man's*
ɛ+i → **ɛɛ**	cíībɛ̌ í → **cíībɛ̀ɛ́**	*woman's*
a+i → **ɛɛ**	síà + í → **síèɛ̀**	*big brother's*

Vowel coalescence also occurs between the PFV verb and the following direct object pronoun, which is **ū** (human) or **ú** (non-human). The fusioned vowel has the back quality of /u/, and the [-ATR] vowels keep their [-ATR] value (see examples in (253)).

(253)

Vowel coalescence	**Verb + object pronoun**	***Gloss***
i + u → iu	fī ú → fīú	*buy it*
e + u → oo	céé ú → cóó	*watch it*
ɛ + u → ɔɔ	pɛ̀ɛ̀kɛ̀ ú → pɛ̀ɛ̀kɔ̀ɔ́	*spy on/watch it*
u + u → uu	fùù ú → fùú	*meet it*
o + u → oo	lōō ú → lōó	*take it*
ɔ + u → ɔɔ	wɔ́ ú → wɔ́ɔ́	*approach it*
a + u → ɔɔ	já́ ú → jɔ́ɔ́	*see it*

6.4.3.2 Analysis

Coalescence, in general, can be accounted for by the UNIFORMITY (UNIF) constraint, as discussed previously. In this study, the method of Casali (1996) is applied. Casali (ibid.) analyzed the seven-vowel system coalescence of Yoruba (Benue-Congo, Nigeria), previously illustrated in (103). The same coalescence patterns are observed in Samue in the vowel coalescence between nouns and the following pronoun or definiteness marker, and the verb and the direct object pronoun.

Casali (1996) proposed a universal ranking for height coalescence positing that [low], [-ATR] and [-high] features dominate [+high] and [+ATR]. The MAX(↓) constraint is employed here to replace Casali's PARSE(↓); it combines the dominating features [low], [-ATR] and [-high] which are not in competition among themselves in coalescence. The constraint MAX(↑) includes both [+high] and [+ATR] features. The MAX(↔) constraint combines [-back] and [round] features that are not linked to vowel height as the previously mentioned features are.

Casali (1996) suggested that in the case of V_1 and V_2, the decision about [-back] and [round] features is always done in favor of the V_2. In general, Casali divided the constraints depending on a specific position versus elsewhere. The same constraints employed by Casali are used here to account for the vowel coalescence in Samue, but there is a difference between the Yoruba and Samue examples. In Yoruba, the examples consisted of prefixes followed by the root, whereas in Samue, the lexical property, i.e. the stem, is in the first position, followed by a grammatical or pronominal element. It seems that in Samue, the grammatical element V_2 is always more prominent, and not the lexical one as in Yoruba. In Samue, the fused vowel is always long, preserving the moraic structure. The constraints employed in the vowel coalescence analysis are the following:

(254) MAX(↑)$_{gr}$: assign a violation mark for every grammatical input vowel [+high], [+ATR] which is not realized in the output

(255) MAX(↓)$_{lex}$: assign a violation mark for every lexical input vowel [low], [-ATR], [-high] which is not realized in the output

(256) MAX(↔)$_{lex}$: assign a violation mark for every lexical input vowel [-back], [round] which is not realized in the output

(257) MAX(↔)$_{gr}$: assign a violation mark for every grammatical input vowel [-back], [round] which is not realized in the output

In Samue, the [-ATR] value of the fused vowels is preserved, if one vowel is [-ATR]; Casali (2003) refers to this as a coalescent [-ATR] dominance (see also 6.4.2). In the following examples, the ranking argument is presented for the hierarchy MAX(↔)$_{gr}$ » MAX(↓)$_{lex}$, MAX(↔)$_{lex}$ » UNIF, MAX(↑)$_{gr}$. As Casali predicted, the features [low], [-ATR] and [-high] dominate [+high], and also these same features in a specific position dominate other positions. In the case of Samue

hiatus resolution, the specific position is V_2 which preserves maximally MAX(↔) features, i.e. the grammatical element determine the backness of the fused vowel. The case of $\text{MAX}(\downarrow)_{gr}$ is more complicated in Samue, as the second element is always a [+high, +ATR] vowel, i.e. /i/ or /u/. Thus, the $\text{MAX}(\downarrow)_{gr}$ demanding the faithfulness of [low], [-ATR], [-high] features is never violated. The same is true for $\text{MAX}(\uparrow)_{lex}$, as the first vowel is never a [+high] vowel in coalescence situations. For these reasons, the $\text{MAX}(\downarrow)_{gr}$ and $\text{MAX}(\uparrow)_{lex}$ constraints are not included in the following analysis.

The examples from (258) to (262) illustrate the vowel coalescence with different vowels. The candidates with diphthongs are not included, because they do not represent a case of coalescence. The second element in the input is always a [+high] vowel, and it is combined with the vowels which are [+ATR] or [-ATR] and [low] or [-high]. For clarity reasons, the violated features are mentioned separately in the columns of each constraint. If both the lexical and grammatical vowels of the input are [+front], such as in (260), the MAX(↔) constraints are violated by no candidate; a candidate with [-front] or [+back] feature would not be plausible.

(258)

/a + i/ [low] [-bk] [-ATR] [+hi] [-hi]	$\text{MAX}(\leftrightarrow)_{gr}$	$\text{MAX}(\downarrow)_{lex}$	$\text{MAX}(\leftrightarrow)_{lex}$	UNIF	$\text{MAX}(\uparrow)_{gr}$
i. ☞ [εε]		* [low]		*	* [+high]
ii. [ii]		***! [low], [-high], [-ATR]			
iii. [aa]	*! [-back]				* [+high]

(259)

/e + u/ [-bk] [+rnd] [-hi] [+hi]	$\text{MAX}(\leftrightarrow)_{gr}$	$\text{MAX}(\downarrow)_{lex}$	$\text{MAX}(\leftrightarrow)_{lex}$	UNIF	$\text{MAX}(\uparrow)_{gr}$
i. ☞ [oo]			* [-back]	*	* [+high]
ii. [uu]		*! [-ATR]	* [-back]		
iii. [ee]	*! [+round]				* [+high]

(260)

/ɛ + i/ [-ATR] [-bk] [-hi] [+hi] [+frn]	MAX(↔)$_{gr}$	MAX(↓)$_{lex}$	MAX(↔)$_{lex}$	UNIF	MAX(↑)$_{gr}$
i. ☞ [ɛɛ]					* [+high]
ii. [ee]		*! [-ATR]		*	* [+high]
iii. [ii]		**! [-ATR], [-high]			

(261)

/a + u/ [low] [+rnd] [-ATR] [+hi] [-hi]	MAX(↔)$_{gr}$	MAX(↓)$_{lex}$	MAX(↔)$_{lex}$	UNIF	MAX(↑)$_{gr}$
i. ☞ [ɔɔ]		* [low]		*	* [+high]
ii. [oo]		**! [-ATR], [low]		*	* [+high]
iii. [aa]	* [+round]				* [+high]
iv. [uu]		***! [low], [-high], [-ATR]			

(262)

/ɛ + u/ [-ATR] [+rnd] [-hi] [+hi] [-bk]	MAX(↔)$_{gr}$	MAX(↓)$_{lex}$	MAX(↔)$_{lex}$	UNIF	MAX(↑)$_{gr}$
i. ☞ [ɔɔ]			* [-back]	*	* [+high]
ii. [oo]		*! [-ATR]	* [-back]	*	* [+high]
iii. [ɛɛ]	*! [+round]				* [+high]
iv. [ee]	*! [+round]	*! [-ATR]			* [+high]
v. [uu]		**! [-high], [-ATR]	* [-back]		

Because of the restrictions which determine which vowel qualities can be in the V_1 or V_2 positions in Samue, all the Casali's (1996) predictions are not thoroughly confirmed. This concerns especially the constraint $\text{MAX}(\downarrow)_{gr}$, which was not employed in the previous analysis, as the grammatical element is always a [+high] and [+ATR] vowel. The basic pattern of the prominence of V_2 in determining the backness of the fused vowel is completely confirmed in Samue, and thus the $\text{MAX}(\leftrightarrow)_{gr}$ constraint dominates $\text{MAX}(\downarrow)_{lex}$.

6.4.4 Vowel deletion

6.4.4.1 Data

Two cases of vowel deletion occur in Samue, namely syncope in a word medial position between consonants and the rare word final vowel elision. When the speech rate is fast, the vowel /i/ is deleted in the second syllable of the word, if the syllable onset is a nasal (/m/ or /n/) or a liquid (/ɾ/ or /l/). Moreover, the high vowel between /p/, /b/ or /k/ and /l/ is often very short or nearly inaudible in fast speed, when the stop is in a word initial position. In this position, /kp/ is not attested with /l/ in the following syllable, which might be an accidental gap. Some examples of both cases of vowel deletion are provided in (263).

(263)

nàmìnă	[nàmnă]	*scorpion*
cìɾìkàá	[cìɾkàá]	*gun*
pīlāā	[pl̄āā]	*to sweep in IPFV*
bílě	[bĺě]	*cloth*
kílě	[kĺě]	*hand*
kílè-mŭ	[kĺèmŭ]	*hands*

The syncope of the /i/ may engender a long [nn] (as in the dialect of Néguéni) or a long [rr] (as in the dialect of Sourani). This phenomenon may be observed with the word /càɾìnă/, *lion*. When the /i/ is deleted, the word may be pronounced [cànnă] (Néguéni) or [càrră] (Sourani). However, the basic pronunciation in Niansogoni is [càrnă]. When the syncope occurs in the first syllable, the following consonant is a lateral that can bear a tone. In the more frequent case, when the syncope occurs in the second syllable, the syllable onset is a resonant, and also the second syllable tone is often the same as the first syllable tone. Thus, the syncope does not perturb the tonal structure of the word.

Sometimes the /i/ is deleted in final position of a monosyllabic word, as is the case with the 2nd person singular pronoun /mì/. However, the elision is an infrequent process in Samue; it is frequently observed only with the **mì** pronoun, but not at all in nouns or verbs in the dialect of Niansogoni[16]. For this reason, the elision is not further analyzed in this study. The elision in the case of **mì** conforms to the patterns of syncope, as the deleted vowel is preceded by a resonant consonant that may bear tone.

6.4.4.2 Analysis

Vowel syncope as a form of vowel weakening or reduction has been thought to be connected to stress (e.g. Bloomfield 1933/1973). Syncope is observed in weak positions, for example an unstressed vowel may syncopate or a vowel in unfooted syllables (see e.g. Blumenfeld (2006) for different syncope realizations). Although lexical tone and overt stress are reported to co-exist, for instance, in some Mixtec languages in Mexico (e.g. de Lacy 2002 and references therein), the phenomenon is rare in Gur, but suggested at least for Dagaare (see Anttila & Bodomo 2009). In Samue, however, there is no support for overt stress.

Gouskova (2003) distinguishes between metrical and differential syncope. Differential syncope as it was called by Cantineau in 1939 (cited in Gouskova 2003:179) may affect different vowels of the vowel inventory of a particular language in different ways. In their OT analysis of syllable structure, Prince and Smolensky (1993/2002) proposed the peak prominence scale according to the sonority of segments. According to this scale, the vowel /a/ is highest in sonority, whereas high vowels are lower in sonority. As a consequence, a higher sonority nucleus is more harmonic, and thus more acceptable, than a nucleus of low sonority (ibid.:17). For these reasons, a high vowel nucleus may be prohibited or deleted in some languages. Gouskova (2003) accordingly employs *NUC/i,u, *NUC/e,o and *NUC/a constraints to account for this phenomenon in syncope analysis. For example, *NUC/i,u claims that /i/ and /u/ syncopate, i.e. they are prohibited in syllable nucleus. This is the case in Mekkan Arabic where high vowels syncopate if the deletion does not create tautosyllabic CC clusters (ibid.).

In Samue, only the front high vowel /i/ syncopates. Therefore, the *NUC/i constraint is employed (264). Other constraints needed in syncope analysis are linked to syllable structure, as there is no overt stress in Samue. *COMPLEX prohibits complex onsets and CODACONDITION demands that coda is a resonant consonant (see (80) and (173) previously). Previously stated CODACONDITION permits only codas which are nasal and homorganic with the following stop. In

[16] In Néguéni dialect, the affirmative particle **ni**, which is **nā** in Niansogoni, may be pronounced as a sole [n] without the final vowel.

the case of syncope the coda may be any resonant consonant. The faithfulness constraint MAXV which demands faithful correspondence of input vowels in the output is low ranked in Samue. The markedness constraint *#C[-lat] is also employed to account for the fact that in some words the onset clusters are permitted, namely if a stop is followed by a lateral (265). This constraint is created in the sense of Hayes and Wilson's (2008) constraint *[-son]C, which prohibits consonant clusters with an initial non-sonorant segment.

(264) *NUC/i: Assign a violation for every syllable nucleus /i/

(265) *#C[-lat]: Assign a violation mark for every initial consonant cluster where the second element is [-lateral]

The syncope analysis is first illustrated with the word **cìrìkàá**, *gun*, where two first syllables both have a /i/ vowel. The ranking in (266) illustrates why the second syllable /i/ is deleted, but not the first one. Syllable structure constraint *COMPLEX and *#C[-lat] prohibit the first vowel deletion.

(266)

/cìrìkàá/	CODACOND	*#C[-lat]	*NUC/i	*COMPLEX	MAXV
i. ☞ [cìr.kàá]			*		*
ii. [cì.rì.kàá]			*!*		
iii. [crì.kàá]		*!	*	*	*

The same ranking is proved when the first vowel is not a /i/. This is illustrated in (267) with the word **nàmìnă**, *scorpion*.

(267)

/nàmìnă/	CODACOND	*#C[-lat]	*NUC/i	*COMPLEX	MAXV
i. ☞ [nam.na]					*
ii. [na.mi.na]			*!		
iii. [nmi.na]		*!	*		*

The example (268) with the word **jìbìnŭ**, *pig*, illustrates the case where the syncope does not occur. This is because syllable structure constraints CODACOND and *#C[-lat] are higher ranked than *NUC/i. Thus, the faithful candidate [ji.bi.nu] wins, although it violates *NUC/i constraint twice.

(268)

/jìbìnŭ/	CODACOND	*#C[-lat]	*NUC/i	*COMPLEX	MAXV
i. ☞ [ji.bi.nu]			**		
ii. [jib.nu]	*!		*		*
iii. [jbi.nu]		*!	*	*	*

The vowel syncope in the first syllable is rarely attested and only if the syncope does not engender a prohibited consonant cluster, as only the stop + lateral clusters are permitted. The word **kílě**, *hand*, in (269) shows the ranking argument that *#C[-lat] is higher ranked than the more general *COMPLEX constraint.

(269)

/kílě/	CODACOND	*#C[-lat]	*NUC/i	*COMPLEX	MAXV
i. ☞ [kle]				*	*
ii. [ki.le]			*!		
iii. [kil]			*!		*

The deleted vowel in Samue is not word final, and thus ANCHOR-R constraint could be adopted from McCarthy and Prince (1995) to prohibit the final vowel deletion as presented in (270). However, the ranking hierarchy proposed here with the five constraints is sufficient to account for the syncope in Samue. In careful speech, where the vowel syncope does not occur, the MAXV dominates the *NUC/i constraint, and thus the faithful input-output correspondence is observed.

(270) ANCHOR-R: Assign a violation mark for every word final input segment which does not have a correspondent in the output

The syncope in Samue changes the moraic structure of the word. However, the binary structure is always preserved. The example (269) with /kílě/ is more complicated, as one of the two vowels is deleted. Nevertheless, in this case, the lateral will bear the tone that was associated with the first vowel, [klě]. Thus, the second element of the onset consonant cluster can be considered as moraic. In basic moraic theory, onsets are considered weight-irrelevant (e.g. Hayes 1989). Consequently, they are not supposed to be moraic. Hayes (ibid.), however, postulates that short consonants may be assigned a mora by some rule. In this study, the syncope of the first vowel is considered as such a case, where the second element of the onset cluster can be analyzed as moraic.

6.4.5 Length variation

6.4.5.1 Data

The monosyllabic nouns in Samue consist of two moras, i.e. the minimal word structure is CVV for phonological words. Most of the disyllabic words with a monosyllabic stem plus the noun suffix also have a long stem vowel having the structure CVV-CV. However, this long stem vowel is short in noun-adjective or noun-numeral complexes with an adjective or a numeral added to the noun stems (see the examples below in (271)), i.e. the noun stem is short CV-. For CVV nouns in the singular with two different vowels, it is possible to state that the second vowel is a singular suffix, whereas for the nouns with a long vowel the situation is less clear, i.e. whether the suffix has the same vowel quality than the stem, or whether the suffix is zero. In all cases, the stem vowel is short in these complex forms, whether the noun is in singular or in plural. In other words, the stem vowel is long in forms stem + CV-suffix, if CVV words are analyzed having the singular suffix -V. Furthermore, some nouns of **-na/-ma** and **-nu/-mu** noun classes having the CVV stem in the singular and in the plural have a short stem vowel in complex structures, but the nasal element of the suffix attaches to the stem (see (272)), i.e. the stem ends in a nasal in noun-adjective or noun-numeral complexes. The only difference between complex structures in the singular and in the plural is the suffix, e.g. **bán-kpě** (*big bridge*, sg) vs. **bán-kpè-mǔ** (*big bridges*, pl). To date, an explanation for this nasal pattern is yet to be discovered.

(271)

Sg	**pl**	***Gloss***	**Noun + adj/num**	***Gloss***
kūá	**kūū-má**	*calabash*	kū-kpèmǔ	*big calabashes*
sìé	**sìì-bě**	*tree*	sì-kpě	*big tree (sg)*
bāá	**bāā-má**	*sheep*	bā-kpèmǔ	*big sheep (pl)*
fèé	**fèè-mǔ**	*greeting*	fè-kpě	*important greeting*

(272)

báá-ná	**báá-má**	*bridge*	bá**n**-kpě	*big bridge*
béé-nú	**béé-mú**	*stool*	bé**n**-wùnà	*new stool*
fùù-nă	**fùù-mă**	*stomach*	fù**n**-kpě	*big stomach*
sèè-ná	**sèè-má**	*truth*	sè**n**-kpě	*big truth*

These types of length variation display a frequent process in Samue. However, there are also cases, where the stem vowel stays long in monosyllabic and disyllabic words as in (273). This is

less frequent than the previous case. Sometimes the reason for keeping the long vowel could be the contour tone, but not in all cases.

(273)

Sg	**pl**	***Gloss***	**Noun + adjective**	***Gloss***
kóó	**kúú-mú**	*head*	kúú-kpĕ	*big head*
fóó	**fóó-mú**	*ash*	fóó-pùá	*black ash*
sā̋ā̋	**sā̋ā̋-sé**	*stalk*	sā̋ā̋-kpĕ	*big stalk*
káà	**káàmă**	*shell*	káà-kpĕ	*big shell*
kpáà-nă	**kpáà-mă**	*shelter*	kpáàn-kpĕ	*big shelter*
fúù-nă	**fúù-mă**	*axe*	fúùn-kpĕ	*big axe*
nɔ̄ɔ́-ná	**nɔ̄ɔ́-má**	*friend*	nɔ̄ɔ́n-kpĕ	*important friend*

There are also a few words with CV-CV structure, as illustrated in (274). Most of these words have a -**na/-ma** suffix, and thus the stem has a nasal attached to it. In singular, in plural, and in noun-adjective complexes the stem is short CV.

(274)

sg	**pl**	***Gloss***	**Noun + adj/num**	***Gloss***
cì-nă	**cì-mă**	*wood*	cìn-kpĕ	*big wood*
pá-ná	**pá-má**	*foot*	pán-bòòmŭ	*two feet*
wè-nŭ	**wè-mŭ**	*thing*	wèn-kpĕ	*big thing*
jḭ̀-pŏ	**jī̋-sĕ**	*fish*	jī̋n-fɔ̀ɔ̀kă	*white fish*

The length variation also occurs in verbs. Monosyllabic CV verbal stems will become CVV in IPFV, if the IPFV suffix is **-see** or **-jee** ((275)). With -**nnee** suffix, the stem will have a nasal coda, as previously stated in 6.3.1.2, and thus the vowel lengthening does not occur. However, a few monosyllabic verbs that have CVV structure in IMP, have a short vowel in IPFV, as illustrated in (276). All these verbs have the -**nnee** IPFV suffix, and they have the rare tone pattern MH (see 7.3.1 and 7.3.2.1 on tone).

(275)

IMP	**IPFV**	***Gloss***
kǎ̰	**kā̃ā̃sēē**	*to scratch*
mà	**māāsēē**	*to hit*
wà	**wāāsēē**	*to lose*
jì	**jīījēē**	*to dirty*
mí	**mííjēē**	*to hide*

(276)

monosyllabic MH-verbs		
tɛ̄ɛ́	**tɛ̄ńnɛ̄ɛ̄**	*to accustom*
nɪ̃ɪ́	**nɪ̃ńnɛ̄ɛ̄**	*to hurt*

6.4.5.2 Analysis

Vowel length variation in Samue displays two cases: vowel shortening and vowel lengthening. An explanation for vowel shortening as in (272) is Osthoff's Law (e.g. Kenstowicz 1994:440), which has been used in analysis of Greek, according to which a long vowel becomes shortened in a syllable which has a sonorant coda if another consonant follows the sonorant. This could explain vowel length variation of nouns with **-na/-ma** suffix, where the nasal element stays in noun-adjective or noun-numeral complexes. In other words, the long stem vowel is shortened because of the nasal coda. However, there is no clear explanation why this nasal of the suffix attaches to the stem in the first place, unless it is part of the root. In that case, the analysis of the singular vs. plural suffix becomes complicated, as the difference between the singular and the plural is within the nasal initial suffixes **-na/-ma**. Moreover, this lengthening does not occur in all cases (compare the words in (272) to (273)).

The words which have the CVV form in singular as in (271) are analyzed as having a CV stem. The CV stem is an underlying property and it is the form also employed in noun-adjective or noun-numeral complexes. In many cases, it is possible to postulate that the singular CVV words consist of a CV stem followed by a V suffix. In some cases, this suffix vowel is coalesced with the stem vowel, as discussed at the end of section 6.3.5.1. This means that the short stem vowel is lengthened in the plural form. The same principle is applied in verbs with IPFV suffixes **-see** and **-jee**, as presented in (275).

A morphophonemic length variation is reported in Gur languages (e.g. Naden 1989). Naden (ibid.) states that, for instance, in Mampruli (Ghana), many CV roots are lengthened before most suffixes. The lengthening of the vowel in the plural may be lexically conditioned. This is also the case in Dagaare, a Gur language spoken in Ghana (Anttila & Bodomo 2009), where the stem vowel is long before **-ri** or **-rɪ** suffixes in some words. In some other words, the CV stem stays short, and thus there is no evidence of lexically conditioned lengthening. Moreover, there is a phonological case of vowel epenthesis in Dagaare in order to have minimally bimoraic words, if the stem is CV, i.e. the metrical structure of bimoraic words is respected. Anttila and Bodomo (2009) argue that the length variation in Dagaare has two sources depending on the situations: 1)

phonological epenthesis or 2) morphological suffixing, which includes lexically conditioned lengthening.

Considering the situation in the Gur languages in general, and in Samue in particular, the interpretation is that vowel lengthening in plural forms of CV noun stems in Samue is due to the lexically conditioned lengthening, as there is no phonological reason that would explain the case, and because in some words the stem stays short or long, respectively. As previously stated, some noun stems are CV and remain so also in plural, although this pattern is rare. Some other words have a CVV stem that remains in the singular and plural and in noun-adjective or noun-numeral complexes. However, the lexical conditioning cannot be the property of suffixes, as the stems with same suffixes display different cases of length variation. Another question is the moraic structure of CVV stems in the case of vowel shortening, i.e. whether the stem becomes monomoraic or if the nasal coda could be accounted for as being moraic. Hence, this is not normally the case, because the nasal coda is analyzed as sharing the mora with the preceding vowel (see discussion on syllable structures in 6.3.1.3).

The lexically conditioned lengthening is not analyzed with more detail in Optimality Theory. Specific constraints could be created to account for the lengthening/shortening in verbs, which take different IPFV suffixes. However, with nouns the situation is more complicated, as there is nothing in the phonological form or in the noun class suffixes which would predict the correct output with lengthening, shortening or faithfulness. More insights into this issue might be obtained in the future, when more Gur languages are analyzed morphophonologically. Moreover, there is a possibility that a detailed analysis of the noun class system in Samue would give a better understanding for the explanation of length variation, although at this point it seems that several noun classes display the same kind of variation.

6.4.6 Section synthesis

Several phonological processes were discussed in this section. **The consonantal assimilation in Samue displays both assimilation of place and manner of articulation**. Nasals assimilate to the place feature of the following stop and other consonants preceded by nasals assimilate to the [nasal] manner feature, especially when the nasal is a subject pronoun. Thus, the assimilation is in many cases reciprocal. The voiceless consonants also become voiced, when preceded by nasals. Accordingly, the AGREE constraints were employed to analyze consonantal assimilation. The faithfulness of nasality and faithfulness of the place of onset consonants dominate the AGREE constraints, and AGREE further dominates the general place and manner faithfulness (see constraint ranking in Figure 21).

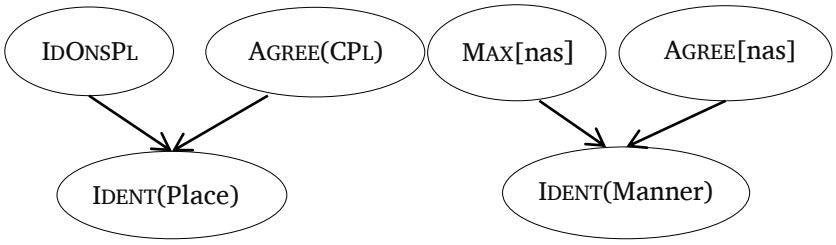


Figure 21. Ranking hierarchy for the place assimilation (left) and manner assimilation (right).

Vowel harmony is attested in Samue according to [ATR] and [back] features. The [back] harmony is mainly respected in stems only, whereas the [ATR] harmony is attested also between noun stems and suffixes. ATR is a frequent phonological process in Niger-Congo languages as in Gur languages. The harmony patterns differ between languages, depending on the vowel system, e.g. if the languages have 7 or 9 contrastive vowels. The role of the neutral vowels also differs. In Samue, the /a/ is neutral, but in some other Gur languages which lack the low [+ATR] counterpart /ə/ as well, the /a/ is not neutral, as is the case in Kɔnni (Cahill 2007a). In Samue, the faithfulness of the stem [ATR] value with the [ATR] agreement and the restriction of adding new [-ATR] segments dominate the constraint that would maximally preserve the [-ATR] segments (see constraint ranking by Hasse diagram in Figure 22). In the case of unharmonic verb forms, AGREE[ATR] is violated and DEP[-ATR] dominates AGREE[ATR].

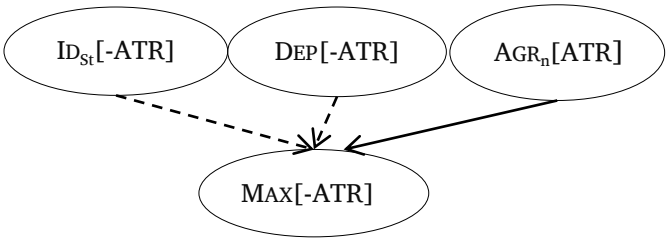


Figure 22. Ranking hierarchy for the ATR harmony in nouns.

Vowel coalescence occurs in Samue between the noun and the following pronoun as well as between the verb and the following object pronoun. In coalescence, [-ATR] value of the vowel is preserved, i.e. **[-ATR] dominance can be observed in vowel coalescence**. Samue proves the predictions of Casali (1996) about ɛ-coalescence in a 7-vowel system, i.e. that the vowel sequence a+i is fused to [ɛ] and not [e], as is the case in many 9-vowel systems. However, the constraint ranking that Casali (ibid.) proposed is not entirely confirmed in Samue, mainly because in Samue the second vowel is always a [+ATR] high vowel, and the first element is never [+high]. The figures below compare the constraint ranking proposed for Samue in this study, and that of Casali

(1996) for 7-vowel system coalescence. The letter P after the constraint in Casali's ranking refers to the specific positions. In the case of Samue, $_{gr}$ and $_{lex}$ are used instead to refer for grammatical and lexical elements, respectively. In the ranking of Samue, the constraints MAX↓$_{V2}$ and MAX↑$_{V1}$ are not associated, as they are never violated, as previously stated because of the vowel qualities of V_1 and V_2. The specific position P corresponds to the grammatical element in Samue.

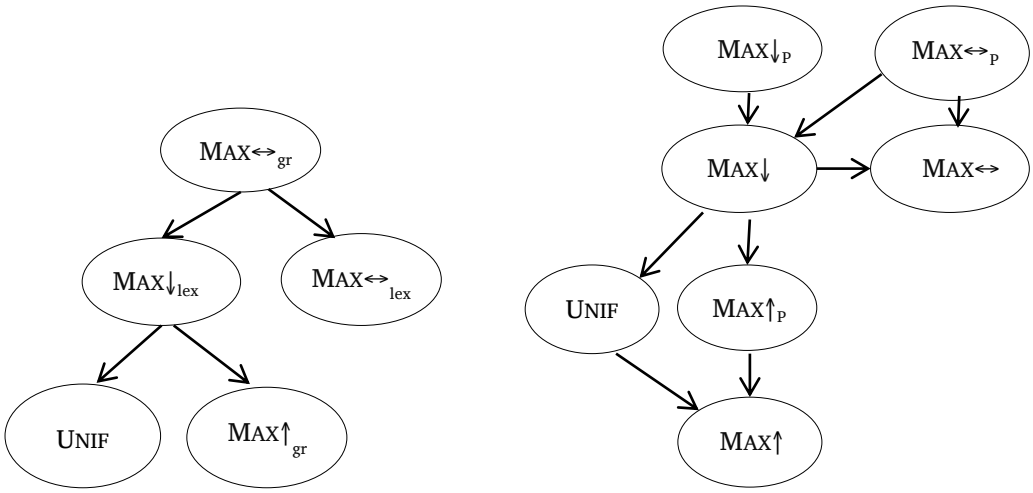


Figure 23. On the left, is the ranking for Samue vowel coalescence used in the present study, and on the right Casali's (1996) constraint ranking.

Vowel deletion between two consonants is observed in the case of the front high vowel /i/. This syncope phenomenon is analyzed by syllable structure constraints, where the low sonority high vowel is prohibited as a nucleus. However, the constraints restricting consonant clusters and positing coda conditions are higher ranked. The first high vowel deletion is an areal feature between a stop and a continuant, according to Naden (1989); this same pattern is observed in Samue, although the continuant is always a lateral. The syncope in the second syllable is not (widely) reported in other Gur languages to date.

Length variation in stems occurs in many Gur languages, as is stated by Naden (1989) and by Bendor-Samuel (1971). However, the analysis of this variation is quite scarce. Anttila and Bodomo (2009) argue that the variation is partly lexically conditioned in Dagaare, and partly dependent on the metrical structure of the language. In Samue, the analysis shows that **the length variation can be considered as a case of lexically conditioned variation** because with some words the stem stays as it is in all possible cases, but some words display length variation.

To conclude, it is possible to state that phonological processes attested in Samue are also largely reported in other Gur languages. A particularity of Samue is the vowel harmony according to the back feature.

6.5 Chapter synthesis of the OT application

The OT application to the phonological system of Samue revealed some interesting points. For instance, the variation in consonant voicing and lenition required that the theory of Partially Ordered Grammars (e.g. Anttila 2002) was applied, because the standard OT requires a fixed ranking hierarchy.

As a whole, **the analysis of Samue sound system demanded no newly created constraints that are not previously employed in the literature**. Some existing constraints were slightly modified (e.g. PAL-i-[-high] (138) and *#C[-lat] (265)) to account for the specific phenomena in Samue. Some constraints were also specified to be applied only to the stems or to the suffixes, e.g. the vowel harmony analysis, or the specific positions in the word, as in the analysis of vowel coalescence.

The OT seems to be suitable for the analysis of a whole phonological system, although it would be challenging to rank all the constraints among themselves, because they treat different sub-domains of the phonology. The ranking hierarchy is quite feasible with the syllable structure (as illustrated in Figure 18 above), for instance, because the amount of variation is limited, and thus the set of constraints is mainly established in the previous studies. The language specific features emerge in cases when, for example, the consonantal assimilation is concerned, i.e. to which sound feature classes the assimilation is applied in the particular language.

Cahill (2007:428) argues that because morphemes are language specific, all the constraints in OT analysis cannot be universal, but rather they are applied in a particular language only. While it is true that morphemes are language specific, the basic principle of OT is that constraints are universal, i.e. to be formulated in such a way that they are useful in the analysis of several languages. This holds true quite easily for the faithfulness constraints, but the matter is different concerning the markedness constraints.

One possibility is to state that a specific markedness constraint, dominating in a particular language, may be so low-ranked in other languages that it does not have a visible effect, i.e. the specific process is non-existent in those languages. Consequently, in the present study, the objective was to employ constraints not specific for particular morphemes, but rather constraints that are specified for phonological features or phenomena. In the phonological analysis this principle was quite successfully applied, but see discussion in section 7.5 for the analysis of the tone system of Samue.

7 TONAL STRUCTURE OF SAMUE

Tonal structure of Samue is examined in this chapter. First, the contrastive lexical tones are introduced and their acoustic realizations are compared. In addition, the question of the Tone Bearing Unit is examined. The following sections describe and analyze tonal melodies and their alternations in nouns, noun phrases complex noun structures, and in verbs and verb phrase, respectively. The chapter ends with a short discussion of tones in pronouns.

Adjectives and adverbs are not analyzed separately in this study. Only a few primary adjectives occur in Samue, while most adjectival meanings are formed from stative verbs. However, the detailed analysis of adverbs and other minor parts of speech are beyond the scope of the present study. Thus, the focus is on the main word classes, namely nouns and verbs.

7.1 Contrastive tones and TBU

There are three contrastive level tones in Samue: high, mid and low. These tones are lexically contrastive, as illustrated by a minimal triplet of verbs in the imperative mood in (277), where the verb is preceded by the 2nd person plural pronoun **á**. Besides its lexical function, tone also has grammatical functions in Samue, which are discussed later especially in 7.3.2 and 7.3.3.

(277)

H	**á sìì**	*Be big!*
M	**á sīī**	*Be old!*
L	**á sìì**	*Be good!*

The same words illustrated above can be presented with pitch contours based on the fundamental frequency (see Figure 24). For the particular informant, the difference between low and mid tone is approximately 15 Hz, whereas the difference between mid and high tones is only 10 Hz. This is due to the fact that he has a very low male voice.

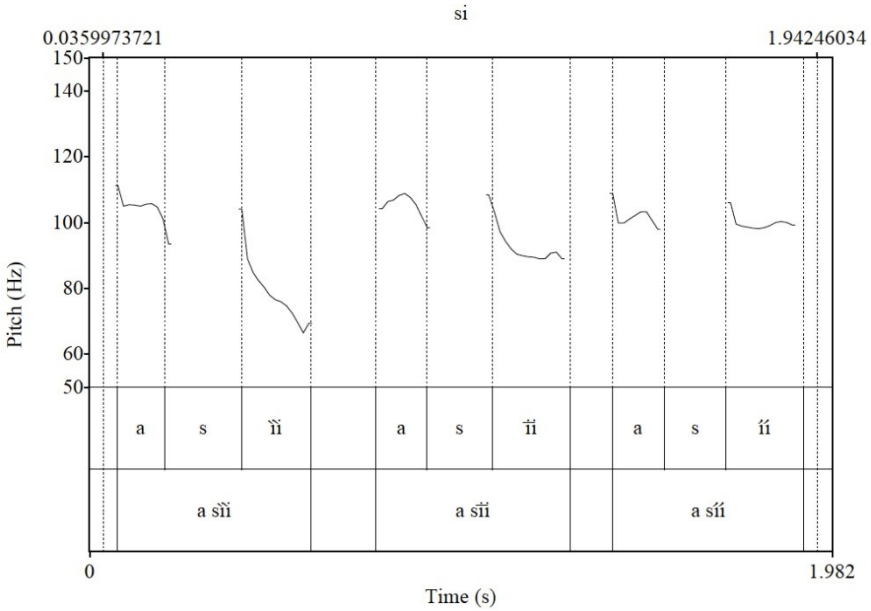


Figure 24. Pitch curves for L, M and H tones.

Tone levels form tonal melodies in nouns and verbs. Tonal melodies behave in a certain manner, depending on the syllable structure of the word or the grammatical alternations. Thus, the complete tonal shape of the word is taken into consideration, instead of looking at the individual tones of different Tone-Bearing Units in a word. These melodies are discussed in further sections (in 7.2.1 for nouns, and in 7.3.1 for verbs).

The automatic process of downdrift as described in 4.2.4.1 is attested in Samue. This means that all H tones in enunciation become somewhat lower after each L tone (and each M tone) until a break in the enunciation, after which the H tone level is set again higher. The phenomenon of downdrift is illustrated in Figure 25 with the sentence **Aá bīlì kàmmá ń wɜ̃ kúá ō kúá bɔ̀**, *Do not use good clothes every day.* All four H tones are marked with Hz values, and it can be observed that the level of each H tone drops, from 122 Hz in the first H tone to 88 Hz in the last H tone at the end of the sentence.

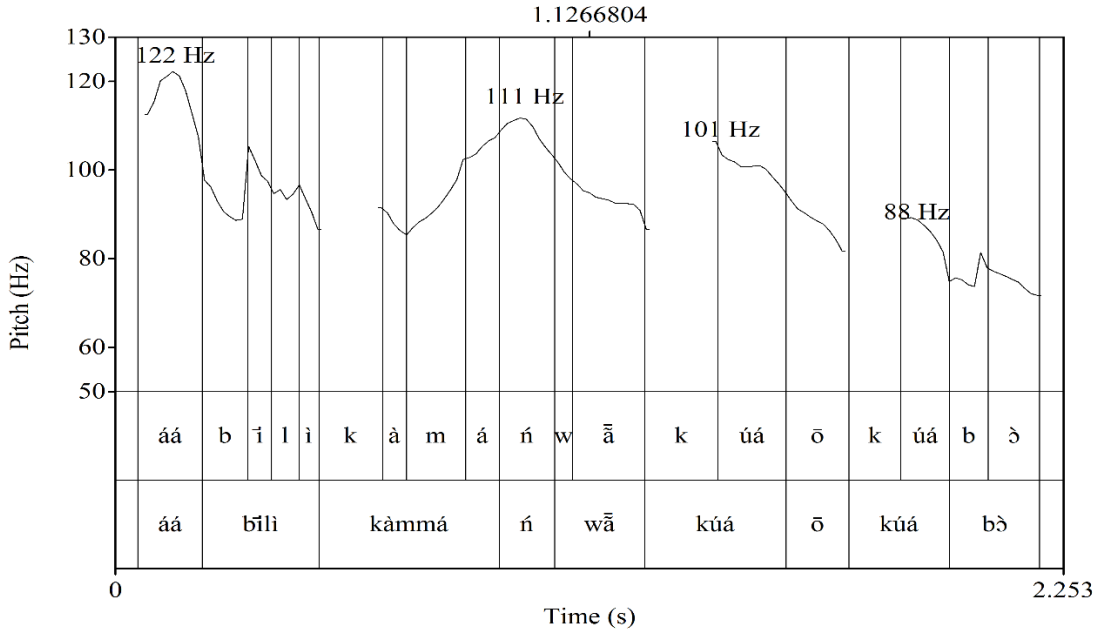


Figure 25. The effect of downdrift.

The **Tone-Bearing Unit** in Samue is the mora. This will be further illustrated in relation to discussion of noun melodies in noun complexes, but the example (278) below shows how the HL melody is divided in syllables depending on the moraic structure of the word. If the stem is a short CV syllable, the L tone of the HL melody is realized on the noun class suffix (**cínă**, *saliva*). If the stem is a monosyllabic CVV syllable, but having two moras, the first vowel has a H tone and the second one a L tone (**tɔ́ɔ̀-nă**, *group*). Whether the disyllabic stem has a short or long vowel in the first syllable, the first syllable bears the H tone and the second one the L tone, as illustrated with the words **kááká**, *tortoise*, and **fákà-nă**, *manner*. It seems, thus, that disyllabic stems behave in a way that the TBU might be a syllable, whereas in monosyllabic stems it is very clear that the TBU is a mora. However, other melodies in disyllabic words support the hypothesis of mora as the TBU, for example the LML-melody in the word **kàlōò-nă**, *carp*, where the long vowel bears the ML-tone combination. A long vowel can, thus, bear a simple tone, doubly associated, or two different tone levels.

(278)

sg	**pl**	***Gloss***
cí-nă	cí-mă	*saliva*
tɔ́ɔ̀-nă	tɔ́ɔ̀-mă	*group*
kááká	káákà-mă	*tortoise*
fákà-nă	fákà-mă	*manner*

Normally the vowel bears the tone, but also syllabic nasals function as TBUs. If a vowel is deleted, liquids may also bear the tone. In other words, sonorant consonants are possible TBUs beside vowels. See examples of different TBU segments in (279).

(279)

kɪ̃ɪ́	*to write*
ǹ	*1st sg pronoun*
kĺě	*hand*

Generally, a TBU in Samue bears only one tone. The nouns pronounced in isolation (i.e. without context), which have the LH tone in the suffix, are transcribed as having a contour on a short vowel. However, this final vowel may be phonetically lengthened. In verbs, the only case of two tones on one TBU is when the bounded M tone spreading occurs (see 7.3.3.3).

There are suggestions that the syllable might usually be the TBU in Gur languages (cf. Yip 2002:141, Cahill 2007a:310). However, there are counter arguments for this proposition, for example Kabiye spoken in Togo has reported to have the mora as TBU (Roberts 2005). It is possible that more comprehensive analysis of tone systems in Gur may reveal the issue in a more detailed way.

Tonal melodies in nouns and in the noun phrase are stable in Samue, although some exceptions are found. More alternations are attested in verbs, as in verbal morphology lexical tone contrasts are sometimes neutralized, and as tone spreads in verb phrase. Tone spreading in verb phrase occurs only when verbal particles are adjacent to verbs; this suggests a syntax-tone interface. These variations are discussed in section 7.3 below. Downstep and tonal polarity do not occur in Samue.

7.2 Tone in noun, noun phrase and noun complexes

Tonal melodies of nouns are examined first. Melodies are analyzed in noun stems, but taking into account noun class suffixes, as the bare stems never occur alone. Noun melody combinations are further discussed in derived and compound nouns. The section ends by an examination of tonal structures in different complex structures, for instance in noun-adjective and noun-numeral complexes, and associative phrases.

7.2.1 Tonal melodies

The three level tones of Samue are combined in nouns in such a way that 11 melodies occur in simple lexemes (i.e. in stems): H, HL, HM, HLH, M, MH, ML, L, LH, LML and LM. The most frequent melodies are H, L and HL (see Table 16). In total, 416 nouns were included in tonal analysis of simple nouns: 170 monosyllabic stems and 246 disyllabic stems). Among 900 nouns, more than a half represents a case of compound or derived nouns. Tone has a distinctive function in Samue, but minimal tonal pairs, however, are quite rare. Approximately 40 minimal pairs are found among 416 nouns; they are presented in Annex 3. Some of the minimal pairs are distinctive only in the singular or only in the plural, because the words belong to different noun classes. Most of the words with trisyllabic stems are complex, i.e. composed of two different stems. For that reason, tonal melodies are examined only in mono- and disyllabic stems.

Table 16. Frequency of tonal melodies in nouns (percentage and number of lexemes).

Melody	Monosyllabic stem		Disyllabic stem		Melody	Monosyllabic stem		Disyllabic stem	
H	36,5%	62	25%	61	**M**	11%	19	6%	15
HL	21%	36	20,5%	50	**MH**	6%	10	3,5%	8
HM	0,5%	1	4%	10	**ML**	1%	2	2%	5
HLH			1,5%	4	**L**	22,5%	38	24%	59
					LH	1%	2	9,5%	23
					LML			3%	8
					LM(H)			1%	3
Total	**58%**	**99**	**51%**	**125**		**41,5%**	**71**	**49%**	**121**

In the following tables, tonal melodies of nouns are illustrated with example words according to the syllable structure of the word. Melodies are grouped by the first tone, i.e. melodies beginning with H, M and L tone, respectively. The noun class suffix is included in the examples and marked by a hyphen. However, tonal melody does not include the tone of the suffix. The noun class suffix is a LH in citation form, if the melody ends in a L tone. The suffix is called LH, although phonetically the rising is not necessarily up to the level of a H tone because of the downdrift. The suffix is a H tone in other cases, i.e. after melodies that end with a M or H tone. Rare melodies are marked by shaded grey in tables; a melody is rare, if less than 10 words are attested among 416 lexemes. The tone realization in square brackets is marked by short level lines; one line for each mora, and in the case of a contour in a long vowel, by a contour line, e.g. [wálá] [¯ ¯] and [káà] [⟍].

7.2.1.1 Nouns with H tone

Four melodies begin with a H tone (see Table 17). The melodies H and HL are very frequent in the tonal system of nouns. The HL melody surfaces differently in mono- and disyllabic stems, i.e. the monosyllabic stem bears the HL in a long vowel, but the disyllabic melody has the H in the first syllable and the L in the second syllable (see examples [tɔ́ɔ̀-nă], *group* and [kɑ́ɑ́kă], *tortoise*). The melody HM is rare, with only eleven stems. Some of these stems are very frequent words, such as **cíībĕ**, *woman*. It is also the only monosyllabic stem with HM-melody, and displays a particular pattern with the suffix tone, which is LH. In other HM-words, the suffix takes the H tone. The rarity of HLH melody (four nouns) and the fact that it is found only in disyllabic stems gives a reason to assume that these words might not be simple lexemes, but rather complex stems. If that is the case, H-melodies could be analyzed as having three different patterns: H, HL and HM.

Table 17. H-melodies in mono- and disyllabic nouns.

	Sg CVV **Pl CVV-CV**	**CVV-CV**	**Sg CV(V)CV** **Pl CV(V)CV-CV**	**CV(V)CV(V)-CV**
H-melodies				
H1) H	[¯] *core*	[¯¯] *classmate*	[¯¯] *straw*	[¯¯¯] *pond*
sg	[kua]	[bɔɔ-na]	[kaala] *mat*	[nafa-na]
pl	[¯¯]	[¯¯]	[¯¯¯]	[¯¯¯]
	[kuu-ma]	[bɔɔ-ma]	[kaala-ma]	[nafa-ma]
H2) HL	[˥˩] *tree*	[˥˩] *group*	[¯ ˊ] *tortoise*	[¯ _ ˊ] *manner*
sg	[jua] *(sp)*	[tɔɔ-na]	[kaaka]	[faka-na]
pl	[˥˩]	[˥˩]	[¯ _ ˊ]	[¯ _ ˊ]
	[juo-ma]	[tɔɔ-ma]	[kaaka-ma]	[faka-ma]
H3) HM		[˥˧] *woman*	[¯ –] *flying*	[¯ – ¯] *grass-*
		[cii-bɛ]	[kãkã] *ant*	[tɛntɛɛ-na] *hopper*
		[˥˧]	[¯ – ¯]	[¯ – ¯]
		[cii-ma]	[kãkã-ma]	[tɛntɛɛ-ma]
H4) **HLH**				[¯ ˊ ¯] *pocket* [cafaa-na]
				[¯ ˊ ¯] [cafaa-ma]

There are a few words with a H melody, where the suffix has a L or LH (see the words *straw* and *shirt* in (280)). Thus, the basic pattern of suffix tone is not followed. There is a possibility that these words join with the noun class -**ba/-se** which has a particular variation pattern between the tone of the stem and the tone of the suffix. With **-ba/-se** class, the tone of the stem varies between singular and plural, but the tone of the suffix remains LH, as illustrated in (281). In other noun classes, the same kind of tonal change is neither attested in the stem, nor in the suffix. All these **-ba/-se** class words refer to animals, except the word **tàkàbă**, *wound*. The -**se** suffix also occurs as H after H-toned stems, and LH after L-toned stems, but in these cases the singular suffix is not -**ba** (examples b) in (281)). The rare singular suffix -**ba** is always realized as LH and attached only to L-toned stems.

(280)

sg	pl	*Gloss*
wíí-jà	wíí-sè	*straw*
símílě	símílé-mŭ	*shirt*

(281)

a)			b)		
sg	pl	*Gloss*	sg	pl	*Gloss*
jɪ̃ɪ̃-bă	jɪ́ɪ́-sě	*antelope*	lìè-nŭ	lìè-sě	*thirst*
nàà-bă	náá-sě	*cattle*	ín-ná	ín-sé	*name*

7.2.1.2 Nouns with M tone

Three melodies have a M melody as the first tone (see Table 18). M and MH melodies do not seem to manifest their difference in monosyllabic CVV words. However, in disyllabic stems the melody MH is clearly distinguished: M in the first syllable and H in the second syllable. The tonal melody ML is rare. When it occurs in monosyllabic stems in isolation (i.e. not adjacent to other words or determiners), the tone of the stem seems to be M. However, in noun-adjective or noun-numeral complexes the stem is clearly ML as in (282) (see also 7.2.3.2).

Table 18. M-melodies in mono- and disyllabic nouns.

	Sg CVV **Pl CVV-CV**	**CVV-CV**	**Sg CV(V)CV** **Pl CV(V)CV-CV**	**CV(V)CV(V)-CV**
M-melodies				
M1) M sg	[ˊ] *sheep* [baa]	[— ¯] *chick* [kpii-ja]	[– –] *thorn* [wulo]	[– – ¯] *tam-tam* [kpoko-nu]
pl	[— ¯] [baa-ma]	[— ¯] [kpii-ma]	[– – ¯] [wulo-mu]	[– – ¯] [kpoko-mu]
M2) MH sg	[ˊ] *spatula* [foo]	[ˊ ¯] *fishing* [cɔɔ-na] *net*	[– ¯] *wasp* [tũta]	[– ¯¯ ¯] *papaya* [mãcee-nu]
pl	[ˊ ¯] [foo-mu]	[ˊ ¯] [cɔɔ-ma]	[– ¯ ¯] [tũta-ma]	[– ¯¯ ¯] [mãcee-mu]
M3) ML sg		[– ˊ] *story* [tɛɛ-na]	[– ˋ] *gall* [kpɛnkpa] *bladder*	[– ˋ ˊ] *tree (sp)* [kasia-na]
pl		[– ˊ] [tɛɛ-ma]	[– ˋ ˊ] [kpɛnkpama]	[– ˋ ˊ] [kasia-ma]

(282)

tɛ̄ɛ̄nă	*story*	**tɛ̄ɛ̀n-tíímú**	*three stories*
		tɛ̄ɛ̀n-kpě	*a long story*

7.2.1.3 Nouns with L tone

Four melodies begin with a L tone. The LH melody has some particularities. In Table 19, both the words **fùú-ná** (*peanut*) and **sɛ̀ɛ̀-ná** (*truth*) are classified as belonging to the same melody, although the stems in isolation seem to have different melodies: LH for *peanut* and L for *truth*. These are the only monosyllabic stems having the a LH melody. The noun-adjective and noun-numeral complexes prove that the melody is LH for both words, as illustrated in (283). The word **sɛ̀ɛ̀-ná** (*truth*) behaves like disyllabic LH words having the H tone only in the suffix. LML and LM melodies are not common.

Table 19. L-melodies in mono- and disyllabic nouns.

	Sg CVV **Pl CVV-CV**	**CVV-CV**	**Sg CV(V)CV** **Pl CV(V)CV-CV**	**CV(V)CV(V)-CV**
L-melodies				
L1) L	[ˊ] *hole*	[_ ˊ] *stomach*	[_ ˊ] *cough*	[_ _ ˊ] *moon*
sg	[pãã]	[fuu-na]	[kɔɔla]	[jimi-na]
pl	[_ ˊ] [pu-bɛ]	[_ ˊ] [fuu-ma]	[_ _ ˊ] [kɔɔla-ma]	[_ _ ˊ] [jimi-se]
L2) LH	[ˊ ¯] *peanut*	[_ ¯] *big lizard*	[_ ¯ ¯] *sheet*	
sg	[fuu-na] [_ ¯] *truth* [sɛɛ-na]	[bɔ̃kã]	[mãka-na]	
pl	[ˊ ¯] [fuu-na] [_ ¯] [sɛɛ-ma]	[_ ¯ ¯] [bɔ̃ka-ma]	[_ ¯ ¯] [mãka-ma]	
L3) LML		[ˊˊ] *bucket*	[_¯ˊ] *young*	
sg		[pallã]	[kãmi-na]	*man*
pl		[_¯ˊ] [pali-ma]	[_¯ˊ] [kãmi-ma]	
L4) LM			[_ ¯] *millet*	
sg			[butɛ-na]	*sack*
pl			[_ ¯] [butɛ-ma]	

(283)

fùú-ná	*peanut*	**fùún-kpě**	*big peanut*
sèè-ná	*truth*	**sèén-kpě**	*big truth*

7.2.1.4 Tonal melodies in subject and object positions

Tonal melodies in nouns are stable when the nouns occur in the subject or direct object position, both when preceding the verb in IPFV or in FUT, and the direct objects in PFV when they follow the verb. Some examples are provided below to illustrate the stability of tonal melodies in the

object position, and more examples with each tonal melody are provided in Annex 4. In the examples in (284), the subject pronoun **ì** has a L tone, followed by the noun and by the verb in IPFV or FUT. The downdrift will occur after all L tones, but it is not marked in the examples. The non-human object is followed by definiteness marker **u** which is merged with the last vowel of the noun (as previously discussed in 6.4.3). In careful speech, where the definiteness marker is pronounced separately, it bears a H tone.

If the noun melody ends in a M or H tone, the fused vowel has a H tone. In the case of the LH suffix, the fused vowel is LH in front of a L- and M-verbs (e.g. the first example below, **ì kànìjɔ̃̌ɔ̃̌ cēēkēē nā**, *he looks at the guinea fowl*). If the verb is H, the rising effect of the suffix does not surface (e.g. the example **ì kpáànɔ̀ɔ̀ fííjēē nā**, *he buys a shelter*). Buli, a Gur language of Ghana, is reported to have a process of Rising Tone Absorption (Akanlig-Pare & Kenstowicz 2002). The authors demonstrate that when a L tone spreads to a H-toned syllable in Buli, the result is a rising tone LH. However, if this tonal sequence is further followed by a H tone, the rising effect disappears. The same kind of pattern is observed in Samue, as the rising of the suffix tone does not surface, when the following verb begins with a H tone.

(284) Tonal melodies in the direct object position

Tonal melody	M-IPFV with M *He looks at X* **ì X cēēkēē nā** [_ X — — –]	HM-IPFV *He buys X* **ì X fííjēē nā** [_ X ¯ — –]	L-FUT in NEG *He won't watch X* **ìì X pɛ̀ɛ̀kà bɔ̀** [_ X _ _ _]
L kànìjǎ (*guinea fowl*)	i **kanijɔ̃ɔ̃** ceekee na [_ _ _ ˊ — — –]	i **kanijɔ̃ɔ̃** fiijee na [_ _ _ _ ¯ — –]	ii **kanijɔ̃ɔ̃** pɛɛka bɔ [_ _ _ ˊ _ _ _ _]
MH fíínú (*donkey*)	i **fiinuu** ceekee na [_ ˊ — — — –]	i **fiinuu** fiijee na [_ ˊ — ¯ — –]	ii **fiinuu** pɛɛka bɔ [_ ˊ — _ _ _]
HM tɛ́ntɛ̄ɛ̄ná (*grasshopper)*	i **tɛntɛɛnɔɔ** ceekee na [_ ¯ – — — — –]	i **tɛntɛɛnɔɔ** fiijee na [_ ¯ – — ¯ — – –]	ii **tɛntɛɛnɔɔ** pɛɛka bɔ [_ ¯ – — _ _ _]
HL kpáànă (*shelter*)	i **kpaanɔɔ** ceekee na [_ \ ˊ — — –]	i **kpaanɔɔ** fiijee na [_ \ _ ¯ — –]	ii **kpaanɔɔ** pɛɛka bɔ [_ \ ˊ _ _ _]

In Annex 5, some examples are also provided for PFV verbs followed by objects of different tonal melodies. These examples further illustrate the stability of the tonal melodies in nouns.

7.2.1.5 Analysis of suffix tones

Tonal melodies in noun stems are stable. However, the suffix tones are LH after L-ending stems, and H-toned in conjunction with M- and H-ending stems. There are at least two possible analyses of suffix tones, as it is somewhat difficult to state the underlying tone of the suffix.

A first hypothesis states that noun class suffixes do not have an underlying tone, but they are toneless and acquire tone from the adjacent stem. In other words, a suffix receives a H from H-stems, and a suffix receives a L from L-stems, accompanied by the rising tone, which could be a H boundary tone. However, M-stems also take H-toned suffixes, i.e. the mid tone does not spread to the suffix, unless M tone spread is accompanied by a boundary tone. This would create a MH contour which is further fused to a H tone. This interpretation demands quite a complex analysis, however. Another possible explanation is that M-nouns, having only a M tone, are prohibited, and thus the suffix receives a H rather than a M tone. However, this does not explain, why the suffix of a M noun does not take a L tone instead.

The second hypothesis postulates that the suffix tone is H, but in the case of L-ending stems, the L tone spreads to the suffix. However, the presence of LH is not maintained in all cases, as discussed in 7.2.1.4, where tonal melodies were illustrated in direct object position. Thus it could be possible to argue that the rising tone is a boundary tone that emerges before a pause, for instance, in isolation. Boundary tones occur in many tone languages, especially to mark the end of an intonational phrase (e.g. Yip 2002). An explanation for the disappearance of the rising tone is also the phenomenon called Rising Tone Absorption reported in Buli (Akanlig-Pare & Kenstowicz 2002), where the H tone of the rising contour LH does not surface when followed by another H tone. The H suffix tone of M- and H-ending melodies always surfaces in suffixes. This could be analyzed by creating a specific markedness constraint that prohibits a rising tone which is followed by a H-toned verb (285). Thus, the H-ABS constraint would dominate the MAX-H constraint. However, this is a tentative analysis and will be analyzed in more detail in the future.

(285) H-ABSORPTION: assign a violation mark for every rising LH tone in noun, which is followed by a H-toned verb

(286)

kpaanɔɔ fii... | |/ | || H L H H	H-ABS	MAX-H
i.☞ [kpáànɔ̀ɔ̀fíí] | |/ǂ || H L H H		*
ii. [kpáànɔ̀ɔ́fíí] | |/ | || H L H H	*!	

If the interpretation of the disappearing rising tone is considered as a process of Rising Tone Absorption, we can suggest that the noun suffix tone is underlyingly a H tone. In the case of L-ending melodies, the L tone spreads to the suffix. This is illustrated below with three constraints. MAX-IO(Tone) requires faithful correspondence of tones in the input and the output, whereas ALIGN-R(Low) requires alignment of the L tone rightwards. ONET/μ prohibits a single mora to bear several tones (287). This constraint was already illustrated in 5.4.1. MAX-IO(Tone) and ALIGN-R(Low) dominate ONET/μ.

(287) ONET/μ: assign a violation mark for every single mora that has more than one tone associated with it.

(288)

/sìì-bé/ |/ | L H	MAX-IO(TONE)	ALIGN-R(Low)	ONET/μ
i. ☞ [sììbě] |/| L H			*
ii. [sììbé] |/ | L H		*!	
iii. [sììbè] |/ǂ L H	*!		

7.2.2 Tone in compound nouns

7.2.2.1 Data

Compound noun structures were briefly introduced in 3.3. In this section, their tonal behavior is discussed with the same examples already illustrated previously. In noun-noun compounds, the second word has always a L tone which rises on the last syllable. The first element of the compound keeps its lexical tone.

(289)

Compound noun	*Gloss*	**1st noun**	*Gloss*	**2nd noun**	*Gloss*
jíì-bàá	*bladder*	**jíì-mŭ**	*urine*	**báà**	*hut, house*
ná-wùlòmŭ	*milk*	**náá-sĕ**	*cattle*	**wúló-mú**	*breast*
pán-tìé	*footprint*	**pā́-ná**	*foot*	**tì-é**	*place, spot*
lóón-wĩ̀ĩ̀jă	*line*	**lóó-nú**	*fishing rod*	**wĩ́ĩ́-já**	*rope*
sì-kòó	*stock*	**sì-é**	*tree*	**kóó**	*head*

A good illustration is the word **báà**, *house*, which always has a LH tone in compounds, whether the first word of the compound word is H, M or L, as illustrated in (290). This means that the original tone of the second word is replaced in compound words.

(290)

báà	HL	*house*	
kéé-bàá	H-LH	*clinic*	*(sick.person-house)*
kpī-bàá	M-LH	*hen house*	*(hen-house)*
wɔ́n-pù-bàá	H-L-LH	*den*	*(bush-animal-house)*

If we take a noun phrase with two nouns instead of a compound word, both words keep their lexical tones and also the noun class suffixes, as shown in (291) with *meat soup* compared to *peanut sauce*.

(291)

fùú-ná **LH-H**	*peanut*	**jā́ā́sé** **H**	*sauce*	→ Compound word	**fùún-jà̀ā̀sĕ** **LH-LH**	*peanut sauce*
námá **H**	*meat*	**jā́ā́sé** **H**	*sauce*	→ Noun phrase	**námá ú jā́ā́sé** **H H**	*meat soup*

In noun-verb compounds, the noun has the lexical tone which is surfaced on the stem. The verb keeps the tonal melody of the citation form. That melody is L-rising in most verbs (see (292)), but some verbs have a M-tone in the citation form.

(292)

Compound noun	*Gloss*	**Noun**	*Gloss*	**Verb in citation form**	*Gloss*
kènú-fɛ̀é	*prayer*	**kènú**	*God*	**fɛ̀é**	*to greet*
kúsù-fɛ̀ɛ	*abortion*	**kúsǔ**	*pregnancy*	**fɛ́ɛ (PFV)**	*to take out*
ná-fùùsèé	*promise*	**náá**	*mouth*	**fùùsèé**	*to throw/to launch*
wīn-jɛ̄sīē-ná	*chagrin*	**wīī-ná**	*interior*	**jɛ̄sīē**	*to spoil, to harm*
wīn-kānmīē-ná	*joy*	**wīī-ná**	*interior*	**kānmīlēná**	*to be good*
súm-kpɛ̀sɛ̀mì-nă	*heartburn*	**súmú**	*heart*	**kpɛ̀sɛ̀mìnă**	*to be acrid*

The tonal behavior of verb-noun compounds (see (293)) is similar to the case of noun-noun compounds; the noun always has a low-rising melody. The verbal base has the tone of the future tense, which is L in many cases. The verb is in the gerundive form, often having the marker -**ni**.

(293)

Compound noun	*Gloss*	**Verb FUT**	*Gloss*	**Noun**	*Gloss*
sùùnì-bàá	*boutique, shop*	**sùùwè**	*sell*	**báà**	*hut*
kùmnì-kpìnnĕ	*mother tongue*	**kùmù**	*born*	**kpínné**	*language*
sàànì-bàá	*hut for sleeping*	**sɛ̀̃**	*dwell*	**báà**	*hut*
tɛ̄ń-pùá	*habit*	**tɛ̄ńné**	*get used to*	**púà**	*thing*

7.2.2.2 Analysis

The tone of the second constituent in compound words is replaced, if it is a noun. The tone in this case is systematically LH, and there is no spreading or other alternation. In the case of noun + verb compounds, constituents maintain their lexical tones, i.e. the tone of the verbal element is not replaced, but it remains the same as in the citation form of the verb.

The tone replacement of the noun constituent in the second position of the compound can be analyzed by faithfulness constraints. The statement is that the second compound element has a

LH tone, thus the MAX-T(noun2) constraint requires the presence of LH tone on the second element (294). The first compound constituent maintains its lexical tone; to account for this the IDENT-T(noun1) constraint is employed (295). These more specific constraints dominate the general IDENT-T constraint which requires a faithful correspondence between tones of the input and the output (296).

(294) MAX-T(noun2): assign a violation mark for every output occurrence of the last compound constituent, if noun, which does not have LH tone

(295) IDENT-T(noun1): assign a violation mark for every first compound constituent whose lexical tone is not identical between input and output

(296) IDENT-T: assign a violation mark for every input tone which does not have an identical correspondent in the output

The word **kɛ́ɛ́-bàá**, *clinic*, is used as an illustration of the tone replacement in compounds (297). The winning candidate [kɛ́ɛ́-bàá] violates only the low-ranked IDENT-T constraint, because the lexical tone of the second constituent is replaced. The faithful candidate with lexical noun tones [kɛ́ɛ́-báà] violates the compound constraint MAX-T(noun2). The candidate [kɛ̀ɛ́-báà] violates IDENT-T(noun1).

(297) **[kɛ́ɛ́-bàá]** + LH-compound tone, *clinic*

kɛɛ baa |/ || H HL LH	IDENT-T(noun1)	MAX-T(noun2)	IDENT-T
i. ☞ [kɛ́ɛ́ bàá] |/ || H LH			**
ii. [kɛ́ɛ́ báà] |/ || H H L LH		*!*	
iii. [kɛ́ɛ́ báá] |/ H LH		*!*	**
iv. [kɛ̀ɛ́ báà] || || LH HL	*!*		

In N-V compounds both constituents preserve their tones. The first element, i.e. the noun, shows its headship by contributing its syntactic category. The analysis of N-V compounds could be done with faithfulness constraints, which demands faithful correspondence with input and output tones in both the noun, as in (295), and the verb (296). Thus, the faithful candidate will win, because both compound constituents preserve their tones. Faithfulness thus out-ranks everything else, and for that reason the formal analysis is not given.

7.2.3 Tone in derived nouns

7.2.3.1 Data

Derived nouns include words derived from verbs (e.g. verb plus agent) and words created with additional morphemes, such as the diminutive morpheme. Additionally, reduplication is counted as a form of derivation. Some examples of each major category are provided below. Tonally, the basic pattern is that the derivational suffix has its own tone, and the lexical tone of the verb or noun is maintained.

The most frequent derivational process is to create nouns from verbs by nominalization. In such a case the verbal stem is taken in the future tense. A suffix -**na** is added, if the verbal stem is used with a verbal extension (for example -**tu** in the verb **wɛ̃́tú**, *to begin*, and -**ni** in the verb **bàmìní**, *to disturb*, are verbal extensions)[17]. The verbal stem has the tone of the future tense. In most of the cases, the tone of the future tense is L, but MH-verbs and some H-verbs make an exception (see section 7.3.2 for more details). The suffix tone is determined by the tone of the verbal stem; if the melody ends in a M or H tone, the suffix is H. When the melody ends in a L tone, the suffix has a LH melody, as in simple nouns. See examples in (298).

(298)

Noun	***Gloss***	**Verb (FUT)**	***Gloss***
bàmìníná	*disturbance*	**bàmì-ní**	*disturb*
kāńné	*punishment*	**kāńné**	*punish*
jàkàsě	*pinch*	**jàkàsè**	*pinch*
tŭ̃mùsě	*agriculture*	**tŭ̃mùsè**	*cultivate*
wɛ̃̀túná	*beginning*	**wɛ̃́-tú**	*begin*
bèlèsíná	*marriage*	**bèlè-sí**	*marry*

The -**ka** suffix is a productive element when creating new nouns from verbs (see examples in (299)); it denotes the instrument. It is added to the gerundive form of the verb, which ends in -**ni**. The tone of the -**ka** is always L rising. The same holds true for the plural form -**kpã̌**, e.g. **mànnìkpã̌**, *mobile phones*. The tone of the gerundive is also determined by the tone of the future tense.

[17] As stated in the previous footnote 4, the analysis of verbal extensions is beyond the scope of the present study.

(299)

Derived noun	*Gloss*	*From verb*	Verb (IMP)
kàllìkă	*ladder*	*to climb*	**kàlà**
jǎníkă	*flashlight*	*to see*	**jǎní**
mànnìkă	*mobile phone*	*to speak*	**mání**
fàmìnìkă	*fan*	*to fan*	**fàmì**
támánkă	*measure*	*to measure*	**támá**

The diminutive morpheme **pie** (**pise** in plural) is tonally as other noun class suffixes. If the morpheme is attached to a noun with a H-melody, the **pie** is H. After a melody ending in a L tone, **pie** is realized as L rising. See examples in (300).

(300)

táká-sě	*wound-pl*	**táká-pié**	*small wound*
jìbì-nǔ	*pig-sg*	**jìbìn-pìé**	*piglet*
kílě	*hand*	**kílè-pìé**	*finger*

The singular suffix for agent nouns is **-ja** and always has a H tone, as does its plural form **-ma** (301). This creates tonal melodies that are non-attested in simple stems (e.g. MLH in **kpōkōmàjá**, *drummer*), as normally the suffixes are LH if the melody of the head word ends in a L tone.

(301)

Stems		**Complex noun**	**Plural form**	*Gloss*	*(gloss of stems)*
kèèlě-kù-já	→	**kèèlèkùjá**	**kèèlèkùmá**	*shepherd*	*(flock-tend-agent)*
námá-sù-já	→	**námsùùjá**	**námsùùmá**	*butcher*	*(meat-sell-agent)*
kpōkō-mà-já	→	**kpōkōmàjá**	**kpōkōmàmá**	*drummer*	*(drum-tap-agent)*
wóókò-já	→	**wóókòjá**	**wóókòmá**	*guard*	(*watch-agent*)

The possessor is expressed with **-sùbě**; its tone is always LH (302). The plural form is **-sìisě**.

(302)

Singular	**Plural**	*Gloss*	*(gloss of stems)*
fɔ̀kɔ́nsùbě	**fɔ̀kɔ́nsìisě**	*policeman*	*(strength-possessor)*
cíífùsùbě	**cíífùsìisě**	*bachelor*	*(woman-without-possessor)*

The suffix **-nǐ** is also employed to refer to agents. Its tone is always L rising (plural form: **càbǎ**).

(303)

Singular	Plural	*Gloss*	*(Gloss of stems)*
bèlèsɨ́-nǐ	bèlèsɨ́-càbǎ	*married*	*(marry-agent)*
jə̀jí-nǐ	jə̃jí-càbǎ	*visitor*	*(visit-agent)*
tɔ̃ńsí-kpɜ̄-bèlèsɨ́-nǐ	tɔ̃ńsíkpɜ̄bèlèsɨ́-càbǎ	*carpenter*	*(chair-pl-repair-agent)*

There are some exceptional combinations, where the singular **-ni** receives a plural **-ma**. According to the principles showed above in (301) and (303), the **-ni** suffix is always L rising and the **-ma** suffix is H as illustrated in (304).

(304)

fùń-nǐ	*blacksmith*	**fùú-má**	*blacksmiths*
jə́ə́-nǐ	*twin*	**jə́ə́-má**	*twins*

Some words use reduplication, which may concern one or two syllables as seen previously in 3.3. Tonally, the reduplicant (i.e. the repeated segments) has the same tone as the base, as illustrated in (305).

(305)

bə̀-bə̀-kúá	*hailstone*	**fùkó-fùkó-nú**	*lung*	**kpɜ̄-kpā-nă**	*harmattan-wind*
fī-fī-nú	*insect (sp)*	**kùló-kùló-nú**	*turkey*	**kpɛ́n-kpɛ́-nă**	*necklace*
kpɔ́-kpɔ́-pìé	*can*	**kùtù-kùtù-nă**	*toy (sp)*	**bɔ̄-bō-nú**	*deaf mute*

7.2.3.2 Analysis

In complex nouns, the stem and the suffix maintain their lexical tones in many cases. This means that the faithfulness of input tones is a dominating feature, and with no changes from the input, a formal analysis is unilluminating. The diminutive morpheme **-pie/-pise** is an exception, as it behaves like the noun class suffixes having the LH tone after L-stems and otherwise the H tone.

Samue uses reduplication as a form of derivation. Yip (2002) analyses reduplication with a MAX-BR constraint that was originally introduced by McCarthy and Prince (1995). It requires

the faithfulness between the base (B) and the reduplicant (R). When applied to tone, the constraint is modified to be MAX-BR(Tone) requiring that the tones of the base are repeated in the reduplicant (306). The MAX-IO(Tone) constraint is also needed to ensure the faithfulness of the tone on the base stem. Yip (2002) illustrates that when the reduplicant takes the tone of the stem, the MAX-BR(Tone) constraint dominates the markedness constraint *TONE, which penalizes every instance of tone. If it is supposed that reduplicated syllables do not remain phonetically toneless, the DEP(T) constraint can also be employed to prohibit additional tones (307), instead of using the *TONE constraint.

(306) MAX-BR(Tone): assign a violation mark for every base tone that does not have a correspondent in the reduplicant

(307) DEP(T): assign a violation mark for every tone which is epenthesized

In reduplication, the reduplicant copies the tone of the base in Samue, and at the same time the base preserves its lexical tone. The following example in (308) with the word **kùló-kùló-nú**, *lung*, illustrates the ranking argument MAX-IO(Tone), MAX-BR(Tone) » DEP(T). If the reduplicant does not take the tone, the MAX-BR(Tone) constraint is violated, and if the base tone is replaced on the reduplicant, MAX-IO(Tone) is violated. Thus, the candidate [kùló-kúló-nú] wins. The losing candidates do not violate DEP(T), as the L tone in ii. would be the result of tone spreading, and iii. displays the tone replacement.

(308)

/RED-kùló-nú/	MAX-IO(TONE)	MAX-BR(TONE)	DEP(T)
i. ☞ [kùló-kùló-nú]			**
ii. [kùlò-kùló-nú]		*!	
iii. [kùló-kúló-nú]	*!		

7.2.4 Tonal alternations in noun phrases and noun complexes

7.2.4.1 Data

Tonal melodies of nouns also remain stable in noun phrases, in the same manner as previously illustrated with nouns in the position of direct object. The LH suffix tone is not present in complex structures of nouns (i.e. noun-adjective and noun-numeral complexes), when only the noun stem

is present. In other words, the rising tone does not belong to the tonal melody, but is attested when the nouns are for example in citation form, as previously stated.

In order to illustrate the stability of tonal melodies, several types of complex forms are provided below, namely noun-adjective and noun-numeral compounds, and demonstrative and indefinite phrases. In the case of noun-adjective and noun-numeral complexes, an adjective or a numeral is added to the bare noun stem, respectively. With demonstrative and indefinite determiners, the noun maintains its noun class suffix. In the examples below, the numeral **tíímú**, *three*, with a H tone, is added to the head noun, and the LH-toned adjective **mĭ̌ĭ́já**, *red*, forms the noun-adjective complex. The demonstrative determiner **nì** (*this/these*) has a lexical L-tone, whereas the indefinite determiner **wúnà** (*any/some*) has a HL tone. In all these cases, the noun precedes the determiner as discussed previously in 3.2. In Table 20 below, all tonal melodies are illustrated in these four cases. The associative construction with two nouns is discussed below.

Table 20. Noun melodies in different types of noun complexes and noun phrases.

melody	**1) Noun + Num**	**2) Noun + Adj**	**3) Noun + DEM**	**4) Noun + INDEF**
Gloss	**tíímú** (*three*)	**mĭ̌ĭ́já** (*red*)	**nì**	**wúnà**
H				
káálá	kaala-tiimu	kaala-mĭ̌ĭ́ja	kaala ni	kaala wuna
straw mat	[¯¯¯¯]	[¯¯ _¯]	[¯¯ _]	[¯¯¯ _]
HL				
kpáànă	kpaan-tiimu	kpaan- mĭ̌ĭ́ja	kpaana ni	kpaana wuna
shelter	[˥ ¯¯]	[˥ _¯]	[˥_ _]	[˥_¯_]
káákă	kaaka-tiimu	kaaka-mĭ̌ĭ́ja	kaaka ni	kaaka wuna
tortoise	[¯¯ _¯¯]	[¯¯ _ _¯]	[¯¯ _ _]	[¯¯ _¯_]
wííjè	wii-tiimu	wii-mĭ̌ĭ́ja	wiije ni	wiije wuna
straw	[¯¯¯¯]	[¯¯ _¯]	[¯¯ _ _]	[¯¯ _¯_]
HM				
ḱákã̄	kãkã-tiimu	kãkã-mĭ̌ĭ́ja	kãkã ni	kãkã wuna
flying ant	[¯¯¯¯]	[¯¯ _¯]	[¯¯_]	[¯¯ ¯_]
			kãkama ni (pl)	
			[¯¯¯_]	
tɛ́ntɛ̄ɛ̄ná	tɛntɛɛ-tiimu	tɛntɛɛ-mĭ̌ĭ́ja	tɛntɛɛna ni	tɛntɛɛna wuna
grasshopper	[¯¯ ¯¯]	[¯¯ _¯]	[¯¯¯_]	[¯¯¯ ¯_]

melody	**1) Noun + Num**	**2) Noun + Adj**	**3) Noun + DEM**	**4) Noun + INDEF**
Gloss	**tíímú** (*three*)	**mĩ̀ĩ́já** (*red*)	**nì**	**wúnà**
HM				
cíībɛ̌	cii-tiimu	cii-mĩĩja	ciibɛ ni	
woman	[˩ ¯ ¯]	[˩ _ ¯]	[˩ ¯ ¯]	
HLH				
cáfàáná	cafaa-tiimu	cafaa-mĩĩja	cafaana ni	cafaana wuna
pocket	[¯ ˊ ¯ ¯]	[¯ ˊ _ ¯]	[¯ ˊ ¯ _]	[¯ ˊ ¯ ¯ _]
M-melodies				
M				
kpārá	kpara-tiimu	kpara-mĩĩja	kpara ni	kpara wuna
stretcher	[¯ ¯ ¯ ¯]	[¯ ¯ _ ¯]	[¯ ¯ ¯]	[¯ ¯ ¯ _]
sāā	saa-tiimu	saa-mĩĩja	saa ni	saa-wuna
palm tree	[¯ ¯ ¯ ¯]	[¯ _ ¯]	[¯ _]	[¯ ¯ ¯ _]
MH				
fīínú	fiin-tiimu	fiin-mĩĩja	fiinu ni	fiinu wuna
donkey	[ˊ ¯ ¯ ¯]	[ˊ _ ¯]	[ˊ ¯ ¯]	[ˊ ¯ ¯ _]
ML				
kpēnkpà	kpɛnkpa-tiimu	kpɛnkpa-mĩĩja	kpɛnkpa ni	kpɛnkpa wuna
gall bladder	[¯ ˩ ¯ ¯]	[¯ ˩ _ ¯]	[¯ ˩ _]	[¯ ˩ ¯ _]
L-melodies				
L				
kànìjǎ	kanijã-tiimu	kani-mĩĩja	kanijã ni	kanijã wuna
guinea fowl	[_ _ _ ¯ ¯]	[_ _ _ ¯]	[_ _ _ _]	[_ _ ˊ ¯ _]
LH				
fùúná	fuun-tiimu	fuun-mĩĩja	fuuna ni	fuuna wuna
peanut	[ˊ ¯ ¯]	[ˊ _ ¯]	[ˊ ¯ ¯]	[ˊ ¯ ¯ _]
sɛ̀ɛ́ná	sɛɛn-tiimu	sɛɛn-mĩĩja	sɛɛna ni	sɛɛna wuna
truth	[ˊ ¯ ¯]	[ˊ _ ¯]	[_ ¯ ¯]	[_ ¯ ¯ _]
LML				
kàlōònǎ	kaloon- tiimu	kaloon-mĩĩja	kaloona ni	kaloona wuna
carp (sp)	[_ ˩ ¯ ¯]	[_ ˩ _ ¯]	[_ ¯ ¯ ¯]	[_ ˩ ˊ ¯ _]
LM				
bùtɛ̄ná	butɛn-tiimu	butɛn-mĩĩja	butɛna ni	butɛna wuna
big sack	[_ ¯ ¯ ¯]	[_ ¯ _ ¯]	[_ ¯ ¯ ¯]	[_ ¯ ¯ ¯ _]

In the previous table, it is possible to see that the noun stem melody does not display any alternations in the noun-adjective and noun-numeral complexes. In the same way, the lexical tones of the numeral, the adjective and the indefinite determiner **wúnà** are maintained. However, some adjectives display tonal changes depending on the lexical tone of the noun stem, and some not, as illustrated in (309) with the adjective **fɔɔka** (*white*), where the tone changes, and with the adjective **kpě** (*big*), which always has a LH tone. A possible analysis is that the stem of **fɔɔka** is unspecified for tone, but having a H suffix tone. Consequently, the tone of the noun spreads to the adjective /kà-fɔɔká/ → [kàfɔ̀ɔ̀ká]. However, all adjectives are not analyzed tonally. Thus, it is not possible to state if there is a rule for this tonal change. The tonal melody of the noun stem is always preserved.

(309)

kà-**fɔ̀ɔ̀kǎ**	*white thing*	kà-kpě	*big thing*
ní-**fɔ́ɔ́ká**	*white person*	ní-kpě	*important person*

The noun suffix is kept with the demonstrative determiner **nì** and with the indefinite pronoun **wúnà**. The L-ending stems having the LH suffix display two different patterns. With the **nì** determiner, the LH suffix tone does not surface, whereas with the **wúnà** pronoun, the rising LH tone is present (compare the examples with the word *guinea fowl*: [kànìjə̰̀-nì] and [kànìjə̰̌ wúnà]).

The tone of the demonstrative determiner **nì** is influenced by the preceding tone. After a H tone, **nì** is realized M, and after a L or a M tone, it is realized L. However, there is an exception with the melody LML, as the last L tone of the stem is raised to M, as illustrated with the word **kàlōònǎ**, *carp,* vs. **kàlōōnā nī**, *this carp.*

The words **kpāɾá**, *stretcher*, and **fíínú**, *donkey*, illustrate clearly the difference between the melodies M and MH, although in singular both words seem to be MH. The plural form of the *stretcher* is **kpāɾā-bɛ́**, having the mid toned stem, whereas the stem of the *donkey* is MH (**fíí-mú)**. When a numeral or an adjective is added to the noun stem, these two tonal melodies behave differently. In other words, the stem is mid with the M melody, and it is MH with the MH melody.

In an associative construction, two nouns are used together to express, for example, possession. An associative marker links these two words together, as discussed in 3.2. Some examples are provided in Table 21 below with different tonal melodies; examples of each tonal melody are illustrated in Annex 6.

Table 21. Tonal melodies in associative phrase.

Dependent noun-sg/pl	**melody**	**Head noun-sg/pl**	**melody**	**Noun phrase**	***Gloss***
jà-á	L	kpín-né	H	jàá ú kpínné [jɔ̀ɔ̀ kpínné]	*song's lyrics*
fī-á	MH	kpáà-nă	HL	fīá á kpáànă [fīɛ́ɛ́ kpáànă]	*small brother's shelter*
kpa̋a̋	M	kóó	H	kpa̋a̋ ú kóó [kpɔ̋ɔ̋ kóó]	*iguana's head*
sì-é	L	wi̋ĭ-bɛ̌	L	sìé ú wi̋ĭbɛ̌ [sìōō wi̋ĭbɛ̌]	*leaves of the tree*
kā́kā̋-má	HM	kúú-mú	H	kā́kā̋má ń kúúmú [kā́kā̋mán kúúmú]	*heads of the ants*
sɛ́ɛ̀-mă	HL	fùù-mă	L	sɛ́ɛ̀mă ú fùùmă [sɛ́ɛ̀mɔ̀ɔ̀ fùùmă]	*big brothers' stomaches*

The associative marker has a H tone in all cases (singular **ú** and plural **ń** for non-humans and singular **í** and plural **ú** for humans) in careful speech. When speech rate is rapid, the final vowel of the noun is fused with the associative marker. In that case, the tone of the AM disappears. Thus, with L-ending melodies, the dependent noun with the fused vowel has a L surface tone, as illustrated with the word **jàá** (*song*) in the construction [jɔ̀ɔ̀ kpínné], *song's lyrics*, above. The only exceptions are CVV words like **sì-é**, *tree*, where a rising effect is present before the second noun, if the second noun begins with a L tone. Nevertheless, it is difficult to state, if the rising is due to the rising suffix tone or the influence of the AM tone. In HL-words, which have the LH suffix, the rising effect is not present, i.e. the last TBU of the dependent noun remains low. This can be seen with the construction [sɛ́ɛ̀mɔ̀ɔ̀ fùù-mă], *big brothers' stomaches*. In a few CVV words having the M melody, the H tone of the AM does not surface (see example **kpa̋a̋**, *iguana*). The vowel coalescence does not affect H-ending nouns.

7.2.4.2 Analysis

Tonal melodies remain stable in complex forms where a numeral, an adjective or an indefinite pronoun is added to the noun. The stability also concerns the numeral and the adjective. The demonstrative determiner **nì**, however, has tonal variation depending on the tone of the noun

stem. The tone of the demonstrative determiner **nì** realized as a M tone after a H-ending noun, but after a L or a M tone, it surfaces as a L tone. It is possible to state, that the underlying tone of the **nì** is L, which becomes M when the determiner follows a H-tone noun. If this hypothesis is adopted, it means that the H tone may spread to the **nì**, but it does not replace the underlying L tone, but the contact of H and L creates a fused tone, which surfaces at the phonetic level of M tone, because the L tone of the **nì** is not delinked. Tonal fusion in generel is reported especially in vowel hiatus positions, for example in Mòbà Yoruba (Benue-Congo, Nigeria), where vowel elision engenders fused tonal forms (Turner 2006). At least for Buli, a Gur language spoken in Ghana, the case of tonal fusion is discussed in conjunction with noun class suffix tones, which might be underlyingly toneless (Schwarz 2003). In Samue, it appears that a HL configuration on a single TBU is interpreted phonetically as a Mid tone. A complete formal analysis of this would involve invoking specific tonal features, and I leave this to a future project.

However, if HL on a single TBU is interpreted as a phonetic Mid (although more frequently H + L sequence would yield to a contour tone HL), the following analysis is possible. In Optimality Theory analysis this means, that the faithfulness of tones is ranked higher than the UNIFORMITY (as in (100)), which prohibits the fusion of tones (or segments). The faithfulness constraints MAX(H) and MAX(L) prohibit the deletion of H and L tones, respectively, as in (310) and (311). In the present study, the complete disassociation of H and L tones, even floating tones, is considered as a violation of MAX constraints, as it is as if the tone is deleted completely. Moreover, an association of several tones to a single mora is prohibited, thus the ONET/μ constraint is employed, see (287) above. The alignment constraint ALIGN-R(H-noun) motivates the H tone spreading of the noun rightwards to the determiner (312).

(310) MAX(L): assign a violation mark for every L input tone which does not have a correspondent in the output

(311) MAX(H): assign a violation mark for every H input tone which does not have a correspondent in the output

(312) ALIGN-R(H-noun): assign a violation mark for every H tone in the noun which does not spread rightwards on the determiner.

The fusion can be illustrated with the word **kàálá**, *straw mat*, in (313). The candidate with a fused M-tone does not violate the high-ranked faithfulness constraints, although it violates the ONET/μ and UNIFORMITY constraints. The winning candidate satisfies the alignment constraint ALIGN-R(H-noun), while the faithful losing candidate [káálá nì] violates it. If the L of the **nì** is replaced, MAX(L) is violated as with the candidate [káálá ní]. The L spreading would violate MAX(H) (candidate iv.).

(313)

H L /|\ | kaala ni	MAX(H)	MAX(L)	ALIGN-R(H-noun)	ONET/μ	UNIF
i. ☞ [káálá nī] |/⌐| H L				*	*
ii. [káálá ní] |/⌐ǂ H L		*!			
iii. [káálá nì] |/ | H L			*!		
iv. [kààlà nì] | H L	*!				

The example above proves the ranking argument for the following hierarchy: MAX(H), MAX(L), ALIGN-R(H) » ONET/μ, UNIFORMITY. Nevertheless, tonal fusion does not occur frequently in Samue. The suggestion is that there is some kind of phonology-syntax interface, and thus a noun with the determiner creates a phonological entity. If **nì** is considered as a clitic, instead of being a suffix or an independent word, this analysis is still more plausible. Otherwise in the language, the H tone of the noun does not spread, for example, in compound nouns. There are, however, some cases, where the H lexical noun tone affects the following adjective, as was illustrated previously in (309). In that case, the tone of the adjective is completely replaced, or it could be stated that some adjectives are underlyingly toneless, and thus they take the tone of the preceding noun.

In associative constructions, the tonal presence of the AM disappears when the vowel coalescence emerges. Thus, the lexical H-tone of the AM marker seems to be weak, although in general the H tone in Samue is prominent (this will be discussed more in relation to verb phrase in section 7.3.3). As in careful pronunciation the AM has a H-tone, whatever the tonal melodies of the dependent and the head noun are, it is not plausible to state that the H-tone is not underlying in Samue. In many Niger-Congo languages, associative marker is H-toned (e.g. Yip 2002), with or without segmental marker. For instance, in Kɔnni (Gur, Ghana), AM is marked by a segmentless H-tone (Cahill 2007a). It would be possible to postulate that the H in Samue is a boundary tone that emerges between two nouns. However, boundary tones are more typically found at the edges of prosodic phrases, for example at the end of an intonational phrase (e.g. Yip 2002). Thus, the analysis of AM as a H-toned segment in Samue is more plausible.

7.2.5 Section synthesis

Three level tones in Samue form 11 different tonal melodies in nouns. The melody system is therefore quite complex, **but tonal melodies have been shown to be stable**, whether the noun forms a noun phrase on its own (for instance as a subject or an object) or it is a part of a noun-adjective or noun-numeral complex. However, some minor tonal alternations are attested. In the following section it is shown that verbs display quite a different system in Samue.

In compound words, the first word (noun or verb) maintains its lexical tone, whereas the noun in the second position takes systematically a L tone, which rises during the last mora, as is always the case with L-nouns in isolation. This means that the lexical tone of the second element is replaced, if it is a noun. Thus, the faithfulness of the first constituent tone is satisfied, and the LH tone is added to mark the compound construction. In noun-verb compounds, the verb keeps the lexical tone of the nominalized form. In complex nouns, the lexical morpheme added to the noun preserves its own lexical tone. An exception is the diminutive morpheme **-pie/-pise**, which behaves like other noun class suffixes; it is L after a L-melody and in other contexts it is realized H. In reduplication, the reduplicant takes the same tone than the base; tonal faithfulness is thus preserved and toneless segments are avoided. In noun phrases, the stability of the tonal melodies is further illustrated. The alternations occur with determiners, such the demonstrative **nì**. With H-ending nouns, the **nì** surfaces with a M tone. This was analyzed as a case of tone fusion.

A noun class suffix with L-melodies is LH, as previously stated and illustrated with the Alignment constraint demanding the spreading leftwards. This rising tone displays three different patterns depending on the context where the noun is placed. First, the rising tone does not surface, when the noun is in direct object position followed by a H-toned verb. This was called High Tone Absorption according to Akanlig-Pare and Kenstowicz (2002). Second, when the L-ending noun, having the LH suffix, is followed by a HL-toned determiner (indefinite pronoun **wúnà**) in noun phrase, the rising tone is maintained faithfully. Third, in associative noun phrases, both the rising suffix tone and H-tone of the association marker do not surface. **These different patterns with a LH tone followed by L or H tones in different syntactic contexts and having different surface representations suggest a possible phonology-syntax interface in Samue**.

In relation to other Gur languages, it seems that Samue nouns are tonally quite typical. When the language has three level tones and many noun melodies, like Bwamu Laa spoken in Burkina Faso, which has 12 noun melodies (Pfurtscheller 2012), the melodies display less tonal processes than if the number of tonal melodies is more reduced (e.g. Liu 2013 for Mbelime of Benin). In two-tone systems, the processes of noun tones often include downstep or spreading (e.g. Roberts 2003 for Kabiye of Togo, and Cahill 2007a for Kɔnni of Ghana), but 3-tone systems typically do not display a downstep (e.g. Akanlig-Pare & Kenstowicz 2002 for Buli of Ghana, Melick 2012

for Mbelime of Benin). However, Snider (1998) reports that the 3-tone language Bimoba (Ghana) has a downstep.

7.3 Tone in verb and verb phrase

First, tonal melodies in verbs are discussed. In subsequent sections, tone realization in verb morphology and tonal alternations in the verb phrase are examined. In several cases, the lexical tone of the verb is neutralized in verb morphology. Other tonal processes occur in verb phrases, namely tone spreading.

7.3.1 Tonal melodies

The lexical tones of the verbs display four melodies in mono- and disyllabic verbs: H, M, L and MH. The H melody is the most frequent, whereas the MH melody is very rare (see Table 22 for the frequencies of each melody). The rare trisyllabic verbs are either H or L. Altogether 369 verbs were analyzed in different frame sentences in order to examine the verbs tonally.

Table 22. The number and percentage of tonal melodies in comparison to the total number of verbs.

Melody	Mono-syllabic		Disyllabic		Trisyllabic		Percentage
H	18,5%	68	24%	89	4%	14	46,5%
M	5,5%	20	9,5%	35			15%
L	14%	52	20%	73	1,5%	6	35,5%
MH	1,5%	6	1,5%	6			3%
Total		**146**		**203**		**20**	**100%**

Below in (314), some examples are provided for all tonal melodies in mono-, di- and trisyllabic verbs. As previously stated, the verb in the imperative mood bears the lexical tone, and thus the verbs below are in imperative forms.

(314)

	Monosyllabics				**Trisyllabics**	
Tone	**CV**	***Gloss***	**CVV**	***Gloss***	**CV.CV.CV**	***Gloss***
H	kpá	*draw water*	kpáá	*open*	jù.rù.mà	*drizzle*
M	pā	*come*	lōō	*take*		
L	nì	*drink*	fùù	*meet*	tè.rè.kè	*apply*
MH			kī̋ī́	*write*		

	Disyllabics			
TON	**CV.CV**		**CVV.CV**	
H	ná.ḱá	*travel*	tóó.kó	*send*
M	bē.lē	*be ready*		
L	fà.mà	*fan*	bɔ̀ɔ̀.kɔ̀	*worry*
MH	kpē.ɾé	*poison*		

7.3.2 Tone realizations in verb morphology

Verb morphology was discussed previously in 3.4. As stated, three verb classes were distinguished in the formation of the imperfective aspect (IPFV) and future tense (FUT): 1) vowel lengthening, 2) vowel addition and 3) syllable addition. Both IPFV and FUT have a specific tonal behavior which will be discussed in this section. The imperative mood and perfective aspect both have the lexical tone of the verb, but the lexical tone contrasts are neutralized in IPFV and in FUT.

7.3.2.1 Imperfective aspect

The basic tonal pattern of the IPFV is a M tone, which is realized either on the IPFV suffix or on both the verb stem and the suffix. In most cases, the verb stem and the suffix take the M tone; the form of the suffix is dependent on the verb class. This is illustrated in (315) for classes 1) and 2), and in (316) for the class 3).

(315)

1) Vowel lengthening				2) Vowel addition			
Tone	**IMP**	**IPFV M**	***Gloss***	**Tone**	**IMP**	**IPFV M**	***Gloss***
L	kà	**kā-ā**	*crunch*	**L**	pùù	**pū-ōō**	*bury*
M	nā	**nā-ā**	*hear*	**M**	bū	**bū-āā**	*remove*
H	cá	**cā-ā**	*offend*	**H**	lí	**lī-ēē**	*kill*
L	fǔ̀kù	**fǔ̄kū-ū**	*turn*	**L**	pɛ̀ɛ̀k-ɛ̀	**pɛ̄ɛ̄k-āā**	*watch*
M	bēlē	**bēlē-ē**	*repair*	**M**	bām-ī	**bām-āā**	*sew*
H	sáká	**sākā-ā**	*wash*	**H**	jííb-í	**jīīb-ēē**	*fill*

With class 3) syllable addition -see or -nnee, the monosyllabic -see verbs are L, M or H, whereas the -nnee verbs are L or H. Disyllabic -see verbs are always lexically L, and disyllabic -nnee verbs L or H.

(316)

3) Syllable addition -**see** or -**nnee**

Tone	**IMP**	**IPFV M**	***Gloss***	**Tone**	**IMP**	**IPFV M**	***Gloss***
L	kǎ	**kǎ̄ǎ̄-sēē**	*scratch*	**L**	fìǎ	**fìǎ̄-nnēē**	*remove embers*
M	nā	**nāā-sēē**	*miss*	**H**	kpá	**kpā-nnēē**	*dry*
H	cíí	**cīī-sēē**	*insult*	**L**	jìlè	**jìlē-nnēē**	*enter*
L	tǔ̀mù	**tǔ̄mū-sēē**	*cultivate*	**H**	wǘkó	**wǘkō-nnēē**	*become satisfied*

There is a group of about 20 H-toned verbs, where the IPFV mid tone is realized on the suffix only, while the verb stem maintains the H tone. All these verbs belong to the verb class 3), and they have the -**nnee** suffix. The few disyllabic MH-verbs also display the same pattern, i.e. the IPFV M tone is realized only on the suffix. MH-verbs have some other alternations as well, as the MH melody on the stem becomes LH. Both these patterns are illustrated in (317). At the moment, there is no hypothesis for explaining the change of MH-stems to LH melody in IPFV, as they do not conform to any existing tonal patterns in the language. However, the few monosyllabic MH-verbs preserve the lexical MH tone in IPFV, but the long vowel is shortened (as previously illustrated in 6.4.5).

(317)

IMP	**IPFV**	***Gloss***
H-Verbs		
tóókó	**tóókó-nnēē**	*send*
tááká	**tááká-nnēē**	*approach*
cólónkó	**cólónkó-nnēē**	*be healthy*
disyllabic MH-verbs		
kūkú	**kùkú-nnēē**	*groan*
pālá	**pàlá-nnēē**	*surprise*
kpɛ̄ɾɛ́	**kpɛ̀ɾɛ́-nnēē**	*poison*
monosyllabic MH-verbs		
tɛ̄ɛ́	**tɛ̄ńnēē**	*accustom*
nī̄ī́	**nī̄ńnēē**	*hurt*

7.3.2.2 Future tense

The future tense is tonally expressed by a L tone, but segmentally it is divided into the same three verb classes as the IPFV. However, the final vowel is always short in FUT. Some examples are provided below in (318) for the first two verb classes, and then in (319) for the class 3) with syllable addition.

(318)

1) Vowel lengthening (not realized in FUT)				2) Vowel addition			
Tone	**IMP**	**FUT**	***Gloss***	**Tone**	**IMP**	**FUT**	***Gloss***
L	kà	**kà**	*crunch*	L	nì	**nì-à**	*drink*
M	nā	**nà**	*hear*	M	tū	**tù-à**	*wash up*
H	cá	**cà**	*bark*	H	pú	**pù-ò**	*urinate*
L	sùmù	**sùmù**	*pound*	L	sìkì	**sìk-è**	*carry*
M	būlō	**bùlò**	*snore*	M	tūlū	**tùl-ò**	*dare*
H	wű́kú	**wů̀kù**	*sow*	H	kpísí	**kpìs-à**	*end*

(319)

3) Syllable addition **-see** or **-nnee**			
Tone	**IMP**	**FUT**	***Gloss***
L	mà	**màà-sè**	*hit*
M	lō	**lò-nnè**	*take*
H	cíí	**cìì-sè**	*insult*
L	fùlò	**fùlò-nnè**	*shut*
H	jílí	**jìlè-nnè**	*call*

Tonally, the only exceptions are those 20 H-toned verbs which maintain their lexical tone of the stem in IPFV. In the future tense, these verbs keep the lexical tone of the stem, and the suffix also is H. The MH-verbs in FUT also has a H-toned suffix, whereas the MH-stem becomes LH. However, the stem of the monosyllabic MH verbs stay MH. Examples of these cases are provided in (320).

(320)

IMP	**FUT**	***Gloss***	**IMP**	**FUT**	***Gloss***
H-verbs			**MH-verbs**		
cééké	**cééké-nné**	*play*	kpēré	**kpèré-nné**	*shorten*
báráká	**báráká-nné**	*stutter*	kūkú	**kùkú-nné**	*groan*
násí	**násí-nné**	*be afraid*	pēlɛ́	**pèlɛ́-nné**	*be too cooked*
			tɛ̄ɛ́	**tɛ̄ńné**	*accustom*
			nīī́	**nī̀ńné**	*hurt*

7.3.2.3 Analysis of IPFV and FUT

Grammatical tone replacement is a fairly frequent tonal process (Hyman & Schuh 1974), and also reported in Gur languages, for example in Dagbani (Hyman & Olawsky 2004). The tonal realization of both IPFV and FUT can be analyzed with the same type of constraints in Optimality Theory. The grammatical tone is inserted and the lexical tone is completely replaced, i.e. deleted. Thus, the constraint demanding the presence of the IPFV tone (321) (or FUT tone, (322)) is higher-ranked than the faithfulness of the lexical tone, MAX-T(Lex) (323).

(321) IPFV(M): assign a violation mark for every imperfective verb TBU which does not have a M tone
(322) FUT(L): assign a violation mark for every future verb TBU which does not have a L tone
(323) MAX-T(Lex): assign a violation mark for every lexical input tone which is not realized in the output

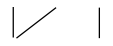
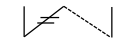
In (324), the IPFV form of the L-verb **kà**, *to crunch*, is analyzed by the IPFV(M) and MAX-T(Lex) constraints. The winning candidate [kāā] violates the low ranked constraint MAX-T(Lex). Both losing candidates, which maintain faithfully the lexical tone of the verb, violate IPFV(M) constraint, either once, as the candidate [kàā], or twice, as the candidate [kàà].

(324) The verb **kà**, *to crunch*, in IPFV (**kāā**)

/kà + a + M/ | L	IPFV(M)	MAX-T(Lex)
i. ☞ [kāā] ⫩ L M		*
ii. [kàā] | | LM	*!	
iii. [kàà] |/ L	*!*	

The lexical tone replacement is complete, i.e. the whole verb stem is concerned. This is illustrated below in (325) with a disyllabic verb in FUT, namely **wűkó**, *to be satisfied*.

(325) The verb **wű́kó**, *to be satisfied*, in FUT (**wǜgònnè**)

/wű́kó + nne + L/ |/ H	FUT(L)	MAX-T(Lex)
i. ☞ [wǜgònnè]  H L		*
ii. [wű́gónnè]  H L	*!*	
iii. [wű́gónné]  H L	**!*	
iv. [wű́gònnè]  H L	*!	

In order to express the inflectional forms of IPFV and FUT, the lexical tone is replaced by the inflectional tone. In the basic case of inflection, the specification of tonal identity (H, M or L) of the lexical tone is not necessary, as the inflectional tone overwrites all the lexical stems. However, there are some exceptional cases, where the H-toned verbs maintain the H in the stem, and the IPFV mid tone surfaces only on the segmental suffix, as seen previously in (317). This pattern also occurs with MH-tones. Moreover, these same verbs express the FUT tense by a H-tone, contrary to the basic pattern of FUT L tone (320). It is challenging to explain why the stem tone is prominent in these specific cases. It cannot be explained phonologically, as the segmental appearance of the verbs is the same as for other verbs. A possibility is to state that the H-tone of these verbs is very prominent for lexical reasons. However, this explanation does not explain why the suffix tone of the FUT is also H, unless the H of the stem spreads. The prominence of H tone in Samue is further discussed in conjunction with the tonal behavior of the verb phrase in 7.3.3 below.

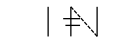
7.3.3 Tonal alternations in verb phrase

In this study, a verb phrase refers to a verb accompanied by a verbal particle, such as an affirmative and negative particle, or tense particles. The most common particles were introduced in section 3.5. In this section, the tonal effect of the particles on the verb is examined.

7.3.3.1 Affirmative and negative particles

The negation particle **bɔ̀** has a L tone and the affirmation particle **nā** has a M tone. They are both placed in a sentence final position. The L tone of **bɔ̀** does not affect the tone of the preceding verb, whereas **nā**, when adjacent with the preceding verb, alternates the tone of the verb by regressive spreading. The **nā** particle affects all L-toned verbs, either perfective L-verbs or the verbs in FUT, which are tonally L. The M tone spreading is unbound on the domain of the verb. This means that all the TBUs of the mono-, di- or trisyllabic verbs surface with the M tone. In (326), the spreading effect of **nā** is illustrated with autosegmental presentation, and compared to sentences with **bɔ̀** particle, where the lexical tone of the verb is maintained.

(326)

FUT-AFF	**Gloss**	**FUT-NEG**	**Gloss**
/ìì kà nā/		/ìì kà bɔ̀/	
 L L M	3s. crunch(FUT) AFF *He will crunch.*	 L L L	3s. crunch(FUT) NEG *He won't crunch.*
[ìì kā nā]		[ìì kà bɔ̀]	
/ìì fàmà nā/		/ìì fàmà bɔ̀/	
 L L M	3s. fan(FUT) AFF *He will fan.*	 L L L	3s. fan(FUT) AFF *He won't fan.*
[ìì fāmā nā]		[ìì fàmà bɔ̀]	
/ìì kɛ̀lɛ̀kà nā/		/ìì kɛ̀lɛ̀kà bɔ̀/	
 L L M	3s caress(FUT) AFF *He will caress.*	 L L L	3s caress-FUT NEG *He won't caress.*
[ìì kɛ̄lɛ̄kā nā]		[ìì kɛ̀lɛ̀kà bɔ̀]	
PFV-AFF		**PFV-NEG**	
/ì kà nā/		/ì kà bɔ̀/	
 L L M	3s crunch(PFV) AFF *He crunched.*	 L L L	3s crunch(PFV) NEG *He did not crunch.*
[ì kā nā]		[ì kà bɔ̀]	
/ì wɔ̀lɔ̀ nā/		/ì wɔ̀lɔ̀ bɔ̀/	
 L L M	3s sleep(PFV) AFF *He slept.*	 L L L	3s sleep(PFV) NEG *He did not sleep.*
[ì wɔ̄lɔ̄ nā]		[ì wɔ̀lɔ̀ bɔ̀]	
/ì kɛ̀lɛ̀kɛ̀ nā/		/ì kɛ̀lɛ̀kɛ̀ bɔ̀/	
 L L M	3s caress-PFV AFF *He caressed.*	 L L L	3s caress-PFV NEG *He did not caress.*
[ì kɛ̄lɛ̄kɛ̄ nā]		[ì kɛ̀lɛ̀kɛ̀ bɔ̀]	

No tonal alternations are observed with M- or H-toned verbs, as illustrated in (327), unless the H-tone is a monomoraic CV, see (328). In that case, the M tone spreads to the H-toned verb. See, however, what happens if the subject pronoun preceding the H CV-verb is H-toned (section 7.4.1).

(327)

PFV AFF	**Gloss**	**PFV NEG**	**Gloss**
/ì sáká nā/ L H M [ì ságá nā]	3s wash(PFV) AFF *He washed.*	/ì sáká bɔ̀/ L H L [ì ságá bɔ̀]	3s wash(PFV) NEG *He did not wash.*
/ì tūlū nā/ L M M [ì tūlū nā]	3s dare(PFV) AFF *He dared.*	/ì tūlū bɔ̀/ L M L [ì tūlū bɔ̀]	3s dare(PFV) NEG *He did not dare.*

(328)

PFV AFF	**Gloss**	**PFV NEG**	**Gloss**
/ì kpá nā/ L H M [ì kpā nā]	3s draw.water(PFV) AFF *He drew water.*	/ì kpá bɔ̀/ L H L [ì kpá bɔ̀]	3s draw.water(PFV) NEG *He did not draw water.*

Objects in PFV or other sentence constituents in FUT, which are placed between the verb and the particle, block the M tone spreading. In (329), the L-toned verb **kà** (*to crunch*) is in a) in PFV, followed by an object noun, and in b) in FUT followed by a postpositional construction *in front of you*. In both of these cases, the verb and the particle are separated, and thus the spreading of M tone does not occur.

(329)

	PFV AFF	Gloss	PFV NEG	Gloss
a)	/ì kà námá nā/ L L H M [ì kà námá nā]	3s crunch(PFV) meat AFF *He crunched meat.*	/ì kà námá bɔ̀/ L L H L [ì kà námá bɔ̀]	3s crunch(PFV) meat NEG *He did not crunch meat.*
b)	/ìì kà mí jǐ́kē nā/ L L H H M M [ìì kà mí jǐ́kē nā]	3s crunch(FUT) 2s.PSS in.front.of AFF *He will crunch in front of you.*	/ìì kà mí jǐ́kē bɔ̀/ L L H H M L [ìì kà mí jǐ́kē bɔ̀]	3s crunch(FUT) 2s.PSS in.front.of NEG *He won't crunch in front of you.*

7.3.3.2 Analysis of unbounded spreading

In unbounded spreading, the ALIGN-L(na) constraint (330), demanding the left alignment of the particle tone, dominates NOLONGT. NOLONGT is a basic tonal constraint requiring that a tone is not associated to several TBUs (331).

(330) ALIGN-L(na): assign a violation mark for every instance of the **na**-particle tone whose left edge does not coincide with the left edge of the domain (i.e. the verb stem)

(331) NOLONGT: assign a violation mark for every tone associated with more than one TBU

The ranking argument ALIGN-L(na) » NOLONGT is illustrated below in (332) with the L-toned verb **kà**, *to crunch*, and with a disyllabic verb **wɔ̀lɔ̀**, *to sleep* in (333). In both cases, the M of **nā** spreads to the preceding verb. The losing candidates violate ALIGN-L(na).

(332)

/ì kà nā/ L L M	ALIGN-L(na)	MAX-T(Lex)	NOLONGT
i. ☞ [kā nā] L M		*	*
ii. [kà nā] L M	*!		
iii. [kà nà] L M	*!*		*

(333)

/ì wɔ̀lɔ̀ nā/ L L M	ALIGN-L(na)	MAX-T(Lex)	NOLONGT
i. ☞ [wɔ̄lɔ̄ nā] L M		*	**
ii. [wɔ̀lɔ̀ nā] L M	*!*		*
iii. [wɔ̀lɔ̀ nà] L M	*!**		**

A basic tonal constraint *DISASSOCIATE prohibits the removal of association lines, as previously seen in 5.4.1. In the case of verb phrases in Samue, the disassociation of a H tone is prohibited by a more specific constraint, namely *DISASSOCIATE(H) (334). *DISASSOCIATE(H) dominates ALIGN-L(na), as illustrated below in (335) with a H-toned verb **kpásá**, *to escape*. The winning candidate maintains faithfully the lexical H-tone, while the losing candidate [kpāsā nā] satisfies the alignment constraint, but violates the high ranked *DISASSOCIATE(H) constraint. The final ranking hierarchy for the M tone spreading of the **nā** particle is: *DISASSOCIATE(H) » ALIGN-L(na) » NOLONGT.

(334) *DISASSOCIATE(H): assign a violation mark for every disassociated H tone.

(335)

/ì kpásá nā/ L H M	*DISASSOC(H)	ALIGN-L(na)	NOLONGT
i. ☞ [kpásá nā] H M		**	*
ii. [kpāsā nā] H M	*!*		**
iii. [kpásā nā] H M	*!	*	*
iv. [kpásá ná] H M		***!	**

The analysis of H tone preservation with the MAX(H) constraint instead of *DISASSOCIATE(H) does not predict the right winning candidate, as illustrated in (336), where candidate iii. is wrongly chosen. In a disyllabic verb, the disassociation of the H tone in the last syllable does not delete the H tone, as only a H is underlyingly present and it is still associated with the first syllable. For this reason, the M tone spreading is analyzed with ALIGNMENT and DISASSOCIATE constraints.

(336) Prediction of a wrong winning candidate iii., indicated by a sad face, ☹.

/ì kpásá nā/ L H M	MAX(H)	ALIGN-L(na)	NOLONGT
i. [kpásá nā] H M		**	*
ii. [kpāsā nā] H M	*!		**
iii. ☞☹ [kpásā nā] H M		*	*
iv. [kpásá ná] H M		***!	**

The M-tone spreading occurs only from the particle to the L-toned verb. It does not occur when other sentence constituents, such as a nominal object, are placed between the verb and the particle, even if they complement the verb. However, see the spreading effect of **nā** particle on object pronouns in 7.4.2.

7.3.3.3 Tense particles

Past tense particles are **ntē** (remote past) and **lɔ̄** (recent past), as discussed in section 3.5.1. They both bear a lexical M tone. The M tone of **ntē** affects the preceding verb, but somewhat differently than the M tone of the **nā** particle examined previously. The M of **ntē** spreads regressively only to the last TBU of the preceding verb, i.e. the spreading is bounded. The spread occurs only with H-toned verbs. As the mora is the TBU, the result of spreading is that a disyllabic verb and a

monosyllabic CVV verb will both have a HM contour, whereas the monosyllabic CV verb will take the M tone. The mid tone of the **lɔ̄** does not spread.

The bounded spreading is illustrated in (337) (in the middle column) with a disyllabic and monosyllabic CVV and CV verbs, compared to the basic PFV sentences with a H-toned verb, where the spreading of **nā** M tone does not occur (on the left), and recent past sentences with **lɔ̄** (on the right), where the spreading does not occur.

(337)

Verb	**3s PFV AFF**	**3s PFV ntē AFF**	**3s PFV lɔ̄ AFF**
kpásá *to escape*	/ì kpásá nā/ L H M [ì kpásá nā]	/ì kpásá **ntē** nā/ L H M M [ì kpásá **ntē** nā]	/ì kpásá lɔ̄ nā/ L H M M [í kpásá lɔ̄ nā]
kpáá *to open*	/ì kpáá nā/ L H M [ì kpáá nā]	/ì kpáá **ntē** nā/ L H M M [ì kpáā **ntē** nā]	/ì kpáá lɔ̄ nā/ L H M M [ì kpáá lɔ̄ nā]
cí *to sew*	/ì cí nā/ L H M [ì cí nā]	/ì cí **ntē** nā/ L H M M [ì cī ntē nā]	/ì cí lɔ̄ nā/ L H M M [ì cí lɔ̄ nā]

7.3.3.4 Analysis of bounded spreading

The analysis of unbounded and bounded spreading differs. In the analysis of bounded spreading, a locality constraint LOCAL could be employed (338). The LOCAL constraint was previously discussed in 5.4.1 according to Yip (2002). The analysis of bounded spreading in Samue, however, demands another constraint, namely a specific EXTEND constraint (338). In addition, the faithfulness constraint MAX(H) requiring the maximal preservation of H tones is posited, because the spreading of the **ntē** particle concerns only H-toned verbs. The reason for employing EXTENDM is to account for the fact that the spreading of the M tone to H-toned verbs with the LOCAL and ALIGNMENT constraint would reverse the previously stated ranking *DISASSOC(H) » ALIGN-L(na). The analysis adopted in the present study with EXTEND is discussed first, and this is followed by the case of reversed ranking.

(338) LOCAL: assign a violation mark for every instance of tone spreading which is not limited to the adjacent elements

(339) EXTENDM [EXTM]: Assign a violation mark for every leftmost edge of **ntē** M tone that is not extended leftwards, exactly to the preceding TBU in the output.

An example of EXTEND was given previously in (111). For bounded M tone spreading in Samue, the EXTEND is posited in a way that the tone extends its domain to the following TBU leftwards (339). If no extend occurs or its domain is larger, the constraint is violated. ONET/μ prohibits more than one tone to be linked with a single mora (see (287)).

Below, the EXTENDM constraint is applied, and the ranking argument EXTENDM, MAX(H) » *DISASSOC(H) » ONET/μ is illustrated in (340) and (341) with a disyllabic verb **kpásá** (*to escape*) and a monosyllabic verb **kpáá** (*to open*). MAX(H) is not obligatory constraint in the bounded spreading, as it is in stringency relation with both EXTENDM and *DISASSOC(H): if both EXTENDM and *DISASSOC(H) are violated, MAX(H) is automatically violated too. As previously stated, in the present study, the MAX(H) and MAX(L) are considered to be deleted even if floating.

(340)

/ì kpásá ntē nā/ | / | | H M M	EXTENDM	MAX(H)	*DISASSOC(H)	ONET/μ
i. ☞ [kpásá ntē] |/ ⟍| H M				*
ii. [kpāsā ntē] ⫽⟍| H M	*!	*!	*!*	
iii. [kpásā ntē] |≠⟍| H M			*!	
iv. [kpásá ntē] |/ | H M	*!			

(341)

/ì kpáá ntē nā/ |/ | | H M M	EXTENDM	MAX(H)	*DISASSOC(H)	ONET/μ
i. ☞ [kpáā ntē] |≠| H M				
ii. [kpāā ntē] ≠| H M	*!	*!	**	
iii. [kpáá ntē] |/ | H M	*!			

The *DISASSOC(H) constraint is higher ranked than ALIGNMENT with the M spreading of the **nā** particle (as it was illustrated in (335)). If bounded spreading in Samue was analyzed with only LOCAL and ALIGNMENT constraints, the *DISASSOC(H) should be low-ranked, as illustrated in (342). Moreover, a specific ALIGNMENT constraint for **ntē** would be needed. For these reasons, the M spreading to the last TBU in Samue is analyzed with the EXTEND constraint, instead of LOCAL and ALIGNMENT constraints. The wrong ranking LOCAL, MAX(H) » ALIGN-L(nte) » *DISASSOC(H) is illustrated in (342). With a monosyllabic verb **kpáá**, *to open*, the ranking of ALIGN-L(nte) higher than *DISASSOC(H) is clearly shown. The faithful losing candidate [kpáá ntē] violates ALIGN-L(nte) twice, whereas the winning candidate [kpáā ntē] only once. Thus, this analysis is rejected.

(342) The rejected analysis of /ì kpáá ntē nā/, *he opened*, realized [ì kpáā ntē nā]

/ì kpáá ntē nā/ |/ | | H M M	LOCAL	MAX(H)	ALIGN-L (nte)	*DISASSOC(H)
i. ☞ [kpáā ntē] |≠| H M			*	*
ii. [kpāā ntē] ≠| H M	*!	*!		**
iv. [kpáá ntē] |/ | H M			**	

When the H-verb adjacent to the **ntē** particle is a monosyllabic CV-verb, the H tone of the verb is completely disassociated. The ranking given above, i.e. EXTENDM, MAX(H) » *DISASSOC(H) » ONET/μ, does not correctly predict this case, as illustrated in (343) with the verb **cí**, *to sew*. The wrongly chosen winning candidate would be [cī ntē] (iii. in (343)). However, this is not the actual output in the language, which is [cī ntē].

(343)

/ì cí ntē nā/ H M M	EXTENDM	MAX(H)	*DISASSOC(H)	ONET/μ
i. [cī ntē] H M		*!	*	
ii. [cí ntē] H M	*!			
iii. ☞ ☹ [cī ntē] H M				*

The above illustration can be explained by the moraic structure, i.e. the H tone linked to only one mora can be disassociated completely, whereas the H tone linked to several moras cannot. Monomoraic H tones are allowed, thus a markedness constraint such as *H(μ) prohibiting monomoraic H tones would be too strong a statement. Rather, the spreading effect of the M tone is stronger than faithfulness to the input tone, when the tone associated with the verb is monomoraic. Consequently, the postulation of the present analysis is that the *DISASSOCIATE(H) constraint is divided to two different constraints distinguishing the moraic structure; *DISASSOCIATE(H)-1μ prohibiting tonal disassociation from a single mora is lower ranked than ONET/μ. *DISASSOCIATE (H) < 2μ penalizes the H tone disassociation from two or more moras, and it is higher ranked than ONET/μ. The examples below in (346) and (347) illustrate the analysis with two different *DISASSOCIATE constraints with the same verbs as used previously: **cí**, *to sew*, and **kpáá**, *to open*.

(344) *DISASSOCIATE(H) < 2μ: assign a violation mark in every case of disassociation of a H tone, which is linked to two or more moras

(345) *DISASSOCIATE(H)-1μ: assign a violation mark in every case of disassociation of a H tone, which is linked to a single mora

(346)

/ì cí ntē nā/ H M M	EXTENDM	*DISAS-SOC(H) < μ2	ONET/μ	*DISASSOC(H)-μ1
i. ☞ [cī ntē] H M				*
ii. [cí ntē] H M	*!			
iii. [cí ntē] H M			*!	

(347)

/ì kpáá ntē nā/ H M M	EXTENDM	*DISAS-SOC(H) < μ2	ONET/μ	*DISASSOC(H)-μ1
i. ☞ [kpáā ntē] H M				
ii. [kpāā ntē] H M	*!	*!		
iii. [kpáá ntē] H M	*!			

This analysis also has a problem when applied to disyllabic verbs. The disyllabic H-verbs will have a contour tone on the last TBU, i.e. the last mora (e.g. **kpásā ntē** illustrated in (340)). However, in monosyllabic CV-verbs this is not allowed; ***cí** is ungrammatical but **cī** is accepted. In other words, in order to be able to analyze the spreading of the **ntē** M tone, the moraic and syllabic structure of the verbs should be accounted for, which leads to a complex analysis beyond the present study.

7.3.4 Section synthesis

In this section, the tonal processes of the Samue verb phrase were discussed. **The IPFV and FUT inflection replace the lexical tones**. This was analyzed by specific the markedness constraints IPFV(M) and FUT(L). Thus, the faithfulness of the input tone is low ranked (see the Hasse diagram in Figure 26 below).

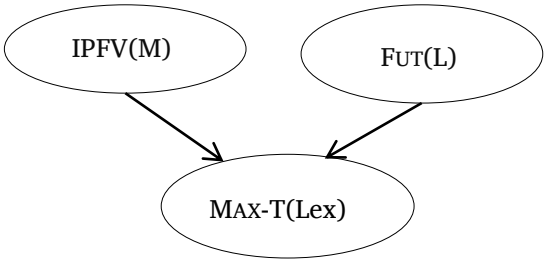


Figure 26. Ranking hierarchy for the lexical tone replacement in IPFV and FUT verb forms.

The basic tonal pattern in the verb phrase is the regressive M tone spreading from the verbal particle to the preceding verb. The spreading is unbounded with the affirmative particle **nā**, as the L-toned verbs surface with a M tone. In the case of the past tense particle **ntē**, the spreading is bounded, affecting only the last TBU of the verb. This difference between bounded and unbounded spreading can be accounted for by the EXTEND(M) constraint, which dominates the *DISASSOC(H) in bounded spreading. The Hasse diagram in Figure 27 illustrates the different rankings for bounded and unbounded spreading in Samue.

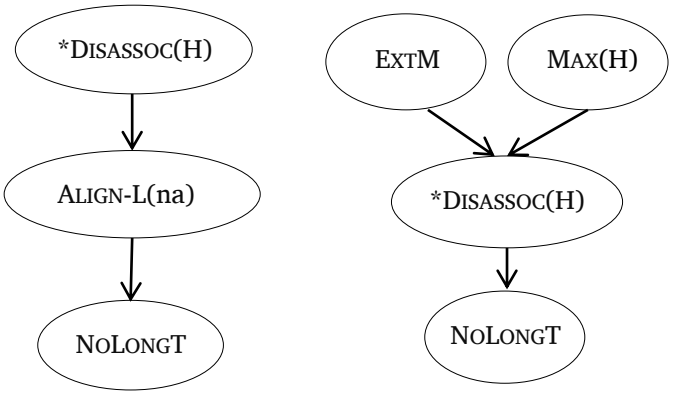


Figure 27. Ranking hierarchy for the unbounded **nā** M tone spreading on the left, and the bounded **ntē** M tone spreading on the right.

The unbounded spreading with **nā** concerns only L-verbs, whereas the spreading with **ntē** particle concerns H-verbs. This is a problematic part of the analysis, i.e. specific constraints are needed. The MAX(H) constraint, which dominates the alignment constraint ALIGN-L(na) explains the restriction that H-toned verbs are intact with **nā** particle spreading. However, it does not give an answer to why the M of **ntē** spreads only to the H-verbs. It could be a lexical property of the **ntē** particle. Another possibility that could be posited is the different featural properties of the M tones. According to Snider's (1999) *Register Tier Theory* (as mentioned in 4.2.1), there are two different M tones, M_1 and M_2, which belong to the different tonal registers, namely low register and high register. One possibility is to suggest that the high register Mid_2 could raise the L-toned verbs, whereas the low register Mid_1 would lower the H-toned verbs. However, this analysis would complicate the tonal system of Samue, positing four different tones, namely, H, M_1, M_2 and L. Thus, this analysis is rejected, i.e. simpler system analysis is more plausible.

Another challenging issue is to find a reason for the M spreading of **ntē**, whereas the M of **lɔ̄** does not spread. However, both are past tense particles. This could be due to the initial nasal in **ntē** that bears a separate M tone. If that is the case, it could be possible to state that the nasal is attached prosodically to the end of the preceding verb creating a nasal coda, and this also affects he tone. A more detailed acoustical analysis could reveal whether the M tone effect is always on the last vowel of the verb, or rather on the nasal part of the **ntē**. If this analysis is opted for, it explains the different behavior between the past tense particles **ntē** and **lɔ̄**. In the case of L-verbs, where the effect of **ntē** does not surface, the M tone is fused with the L tone. This interpretation also explains why the last TBU (i.e. a single mora) bears a contour tone (e.g. **kpásā̌ ntē**, *to escape*); i.e. possibly it is the nasal of **ntē** that bears the tone.

To summarize, it is possible to posit that the tone prominence and prosodic entities the particles form with the verbs control the tone spreading in the Samue verb phrase.

7.4 Tone and pronouns

In this section, tonal performance of subject and object pronouns is discussed. Subject pronouns are examined in a context where they are adjacent to the verb. Object pronouns are studied in different aspects and tenses, as the position of the object changes according to aspect/tense. The first sections discuss human pronouns; the section 7.4.4 concentrates on non-human pronouns.

7.4.1 Subject pronouns

Human subject pronouns have a L tone, except for the 1st person singular, which is a high **ń** in PFV, and HL **ńtì** in IPFV and in FUT (see (348) for human subject pronouns). When the PFV H-verb is CV, the H tone in affirmative sentences is realized with a mid tone, because of the M tone spreading of the **nā**. However, as the 1st person singular has a H tone, the verb also maintains its H tone. This is illustrated below in (349). However, the PFV M-verbs remain M, also with the 1st person singular pronoun. This means that the H tone of the pronoun does not spread to the verb, but rather that two consecutive H tones have a blocking effect.

(348)

	sg	**pl**
1	ń, ńtì	tì
2	mì	à
3	ì	pì

(349)

	1s PFV AFF		3s PFV AFF		3s PFV NEG	
H, **kpá** (*to draw*)	/ń kpá nā/	[**ń kpá** nā]	/ì kpá nā/	[**ì kpā** nā]	/ì kpá bɔ̀/	[ì kpá bɔ̀]
M, **fu** (*to be able*)	/ń fū nā/	[**ń fū** nā]	/ì fū nā/	[**ì fū** nā]	/ì fū bɔ̀/	[ì fū bɔ̀]

Two adjacent H tones have a blocking effect, and thus the M tone of the **nā** does not spread. This is illustrated below, where a H-toned CV verb **kpá** (*to draw*) remains H in conjunction with the 1st person singular pronouns in (352), whereas with the L-toned 3rd person pronoun, the spreading of M occurs, as illustrated in (353). The spreading of **nā** to H-toned verbs occurs only in this specific case, where the verb is a monomoraic CV-verb (see more for **nā** spreading above in 7.3.3.1).

A tentative of analysis is done with the faithfulness constraint MAX(H,H), as in (350), which requires a faithful correspondence of two H tones in the input and the output. The faithful candidate /ń kpá nā/ wins in (352), as it does not violate the high-ranked constraint MAX(H,H), whereas the unfaithful candidate /ì kpā nā/ wins in (353), because in that situation the optimal output is chosen by the ALIGN-L(na) constraint. The *DISASSOC(na) prohibits the disassociation of the M tone of the **nā** particle (351).

(350) MAX(H,H): assign a violation mark for every input sequence of two H tones which does not have correspondent in the output

(351) *DISASSOC(na): Assign a violation mark for every occasion when the tone of the particle **nā** is disassociated.

(352)

/ń kpá nā/ H H M	MAX(H,H)	*DISASSOC (na)	ALIGN-L(na)	NOLONGT
i. ☞ [ń kpá nā] H H M			*	
ii. [ń kpā nā] H H M	*!			*
iii. [ń kpá ná] H H M		*!	**	*

(353)

/ì kpá nā/ L H M	MAX(H,H)	*DISASSOC (na)	ALIGN-L(na)	NOLONGT
i. ☞ [ì kpā nā] L H M				*
ii. [ì kpá nā] L H M			*	
iii. [ì kpá ná] L H M		*!	**	*

7.4.2 Object pronouns

The tone of the direct object is partly influenced by the tone of the context. In PFV, the object follows the verb. The tone of the plural persons (**tímí**, **ámí** and **péé**) is always H. The singular persons (**be**, **mi** and **u** which is merged with the verb) surface as M after a H-verb (see section 3.6 for all pronoun forms). After a L-verb in an affirmative sentence, the verb is raised to M and

the pronoun is also M. When the L-verb sentence is negative, the pronouns like the whole phrase are L. Tonal realization of the pronouns is illustrated below in (354) with a H-verb **céé** (*to watch*) on the left side and with a L-verb **mà** (*to hit*) on the right side. The sentences are given both in affirmative and in negative with all persons. The singular pronoun tones are not marked in the phonological form; see discussion below for the underlying tone of the tones.

(354)

	céé *to watch*		**mà** *to hit*	
	H-PFV AFF	**H-PFV NEG**	**L-PFV**	**L-PFV NEG**
	He watched X	*He didn't watch X*	*He hit X*	*He didn't hit X*
	Singular			
1s	/ì céé **be** nā/ [_ ‾ – –]	/ì céé **be** bɔ̀/ [_ ‾ – _]	/ì mà **be** nā/ [_ – – –]	/ì mà **be** bɔ̀/ [_ _ _ _]
2s	/ì céé **mi** nā/ [_ ‾ – –]	/ì céé **mi** bɔ̀/ [_ ‾ – _]	/ì mà **mi** nā/ [_ – – –]	/ì mà **mi** bɔ̀/ [_ _ _ _]
3s	/ì cóo nā/ [_ — –]	/ì cóo bɔ̀/ [_ — _]	/ì mòo nā/ [_ — –]	/ì mòo bɔ̀/ [_ — _]
	Plural			
1p	/ì céé **tímí** nā/ [_ ‾ – – –]	/ì céé **tímí** bɔ̀/ [_ ‾ – – _]	/ì mà **tímí** nā/ [_ _ – – –]	/ì mà **tímí** bɔ̀/ [_ _ – – _]
2p	/ì céé **ámí** nā/ [_ ‾ – – –]	/ì céé **ámí** bɔ̀/ [_ ‾ – – _]	/ì mà **ámí** nā/ [_ _ – – –]	/ì mà **ámí** bɔ̀/ [_ _ – – _]
3p	/ì céé **péé** nā/ [_ ‾ ‾ –]	/ì céé **péé** bɔ̀/ [_ ‾ ‾ _]	/ì mà **péé** nā/ [_ _ ‾ –]	/ì mà **péé** bɔ̀/ [_ _ ‾ _]

In (355), the M-verb **lōō** (*to take*) is accompanied by object pronouns in affirmative and negative sentences. The tone of the singular pronoun surfaces as M in affirmative and as L in negative sentences.

(355)

lōō *to take*	**M-PFV AFF**	**M-PFV NEG**	**M-PFV AFF**	**M-PFV NEG**
	He took X	*He didn't take X*	*He took X*	*He didn't take X*
	Singular		**Plural**	
1st	/ì lōō **be** nā/ [_ ‾ – –]	/ì lōō **be** bɔ̀/ [_ ‾ _ _]	/ì lōō **tímí** nā/ [_ ‾ – – –]	/ì lōō **tímí** bɔ̀/ [_ ‾ – – _]
2nd	/ì lōō **mi** nā/ [_ ‾ – –]	/ì lōō **mi** bɔ̀/ [_ ‾ _ _]	/ì lōō **ámí** nā/ [_ ‾ – – –]	/ì lōō **ámí** bɔ̀/ [_ ‾ – – _]
3rd	/ì lōō nā/ [_ ‾ –]	/ì lōō bɔ̀/ [_ – _ _]	/ì lōō **péé** nā/ [_ ‾ ‾ –]	/ì lōō **péé** bɔ̀/ [_ ‾ ‾ _]

When perfective verbs with verbal extensions take the direct object, the object pronoun is positioned between the verb and the extension[18]. It then follows that the singular object pronoun surfaces L, whereas the plural pronouns are always H. This is illustrated in (356) with L, M and H verbs, where the extension is **sí**. As previously stated, the function and semantics of the verbal extensions are not studied in detail in the present study.

(356)

	bá sí (*to help*)		**mà sí** (*to wake*)		**būrū sí** (*to scratch*)	
	He helped X		*He woke X*		*He scratched X*	
1s	ì bá **be** sí nā	[_ ¯ _ – –]	ì mà **be** sí nā	[_ _ _ – –]	ì būrū **be** sí nā	[_ – – _ – –]
2s	ì bá **mi** sí nā	[_ ¯ _ – –]	ì mà **mi** sí nā	[_ _ _ – –]	ì būrū **mi** sí nā	[_ – – _ – –]
3s	ì bɔ́ɔ sí nā	[_ ¯ _ – –]	ì mɔ̀ɔ sí nā	[_ — – –]	ì būrūu sí nā	[_ – – _ – –]
1p	ì bá **timi** sí nā	[_ ¯ – – – –]	ì mà **timi** sí nā	[_ _ ¯ – – –]	ì būrū **timi** sí nā	[_ – – ¯ – – –]
2p	ì bá **amie** sí nā	[_ ¯ – – – –]	ì mà **amie** sí nā	[_ _ ¯ – – –]	ì būrū **amie** sí nā	[_ – – ¯ – – –]
3p	ì bá **pɛɛ** sí nā	[_ ¯ — – –]	ì mà **pɛɛ** sí nā	[_ _ — – –]	ì būrū **pɛɛ** sí nā	[_ – – — – –]

In IPFV, the pronoun precedes the verb and its form is slightly different than in PFV. The tone of the 1st person singular **n** is L, except when the verb is H; in that case the **n** is realized as M. The 2nd and 3rd persons singular (**mi** and **i**) and all plural persons (**ti**, **a** and **pi**) are realized tonally on the same level as the verb. The exceptional case of the 1st singular person may be due to the fact that it is a nasal, which attaches more to the subject pronoun than to the following verb. Examples are provided below in (357) with the verb **céé** (*to watch*), which is M (**cēēkēē**) in IPFV, and the verb **tóókó** (*to send*), which is realized HM (**tóókónnēē**) in IPFV.

(357)

	M-IPFV cēēkēē (*He X watches)*		**HM-IPFV tóókónnēē** *(He X sends)*	
Singular	ì **n** cēēkēē nā	[__ — — –]	ì **n** tóókónnēē nā	[_ – — – — –]
	ì **mi** cēēkēē nā	[_ – — — –]	ì **mi** tóókónnēē nā	[_ ¯ — – — –]
	ì **i** cēēkēē nā	[_ – — — –]	ì **i** tóókónnēē nā	[_ ¯ — – — –]
Plural	ì **ti** cēēkēē nā	[_ – — — –]	ì **ti** tóókónnēē nā	[_ ¯ — – — –]
	ì **a** cēēkēē nā	[_ – — — –]	ì **a** tóókónnēē nā	[_ ¯ — – — –]
	ì **pi** cēēkēē nā	[_ – — — –]	ì **pi** tóókónnēē nā	[_ ¯ — – — –]

[18] The word order is the same, even if the object is a full noun, i.e. verb-object-extension.

The future tense is tonally L; therefore the object pronoun which is placed in front of the verb is M. The first person singular, however, is realized with a L tone. As in IPFV, the 1st person singular nasal attaches prosodically to the preceding subject pronoun. The examples in (358) are in negative sentences, because in affirmative, the verb is raised to M because of the M tone spreading of the **nā** particle. In the affirmative future tense, the pronouns surface as in IPFV, i.e. the pronoun is M with a M-verb and H with a H-verb.

(358)

Singular	**pɛ̀ɛ̀kà**, *to watch*	**Plural**	
He won't watch X			
ìì **n** pɛ̀ɛ̀kà bɔ̀	[_ _ _ _]	ìì **ti** pɛ̀ɛ̀kà bɔ̀	[_ – _ _ _]
ìì **mi** pɛ̀ɛ̀kà bɔ̀	[_ – _ _ _]	ìì **a** pɛ̀ɛ̀kà bɔ̀	[_ – _ _ _]
ìì **i** pɛ̀ɛ̀kà bɔ̀	[_ – _ _ _]	ìì **pi** pɛ̀ɛ̀kà bɔ̀	[_ – _ _ _]

The indirect object pronouns (**bee, majee, isee, timiee, amie** and **pee**) always surface as HM, and thus it is plausible to posit that their underlying tone is HM. They are placed after the verb. Examples are provided in (359) with the verb **mání**, *to speak*, which is **mānnēē** in IPFV and **mànnè** in FUT.

(359)

	He speaks to X	*He spoke to X*	*He will speak to X*
	M-IPFV mānnēē	**H-PFV mání**	**L-FUT mànnè**
1s	ì mānnēē **béē** nā [_ – _ – –]	ì mání **béē** nā [_ – – – –]	ìì mànnè **béē** nā [_ _ – –]
2s	ì mānnēē **májēē** nā [_ – _ – –]	ì mání **májēē** nā [_ – – – –]	ìì mànnè **májēē** nā [_ _ – _ –]
3s	ì mānnēē **ísēē** nā [_ – _ – –]	ì mání **ísēē** nā [_ – – – _ –]	ìì mànnè **ísēē** nā [_ _ – _ –]
1p	ì mānnēē **tímíēē** nā [_ – _ – –]	ì mání **tímíēē** nā [_ – – – – _ –]	ìì mànnè **tímíēē** nā [_ _ – – _ –]
2p	ì mānnēē **ámíēē** nā [_ – _ – –]	ì mání **ámíēē** nā [_ – – – – _ –]	ìì mànnè **ámíēē** nā [_ _ – – _ –]
3p	ì mānnēē **péē** nā [_ – _ – –]	ì mání **péē** nā [_ – – – –]	ìì mànnè **péē** nā [_ _ – – –]

7.4.3 Analysis of pronoun tones

The plural object pronouns in PFV are H, whereas singular object pronouns seem to be underlyingly L. They are raised to M when followed by the M-toned affirmative particle **nā**, and also when the verb is H. Another possibility would be to state that the underlying tone of the object pronoun is M, which is lowered to L when adjacent to the L-toned negative particle **bɔ̀**, except when the verb is H. However, there is no evidence in other contexts that the L tone of the **bɔ̀** spreads. If the pronoun is considered underlyingly toneless, the tonal processes are somewhat more complex, because the pronoun is supposed to take both the tone of **nā** and **bɔ̀** particles, except when adjacent to a H-toned verb. Therefore, the pronoun surfaces M with both **nā** and **bɔ̀** particles. The analysis of L as underlying tone of the singular pronouns is opted for. The tonal pattern with verbal extensions, as illustrated in (356), supports this interpretation.

In IPFV, when the pronoun precedes the verb, the verb has an effect on the tone of the pronoun. The interpretation is that IPFV/FUT direct object pronouns are underlyingly M, because in negative FUT sentences the pronoun surfaces as M, although the verb and the following negation particle are both L. However, when the pronoun precedes a H-toned verb, the tone of the pronoun is raised to H, i.e. the H tone spreads regressively to the pronoun. Another possible analysis is to state that the IPFV/FUT pronoun is underlyingly H, but it is lowered when adjacent to M or L tones. However, it is difficult to propose a reason as to why the lowered H-tone is on the same phonetic level with both M and L tones. Consequently, the interpretation of M tone in IPFV/FUT pronouns is adopted.

The tonal influence of adjacent elements in Samue is prominently regressive. When the pronoun is positioned after the verb, it is tonally affected by the verbal particle, whereas when the pronoun precedes the verb, as in IPFV and FUT, the tone of the verb influences the pronoun. This can be analyzed by an alignment constraint which requires left edge tonal coincidence, as was already illustrated with the M-tone spreading of the **nā** particle.

First, the M spreading to the pronoun is illustrated in (360) with a L-verb sentence **ì mà bè nā**, *he hit me* in (360). The ALIGN-L(na) and *DISASSOC(na) constraints dominate NOLONGT. The M tone spreads leftwards, to the pronoun, but it does not affect the verb, i.e. the spreading concerns only the next prosodic word leftwards, see the winning candidate i. compared to the candidate iii. in (360).

(360)

/ì mà bè nā/ L L L M	ALIGN-L(na)	*DISASSOC(na)	NOLONGT
i. ☞ [mà bē nā] L L M			*
ii. [mà bè nā] L L M	*!		
iii. [mā bē nā] L L M			**
iv. [mà bè nà] L L M	*!*	*!	*

In IPFV, where the pronoun precedes the verb, H-toned IPFV-verbs affect the pronoun. This is demonstrated in (362), where the sentence **ì mī tóókónnēē nā**, *he accompanies you*, is analyzed with ALIGN-L(pro) (361) and IDENT-T constraints. The faithful candidate [mī tóókónnēē] violates the alignment constraint, and it is thus the loser.

(361) ALIGN-L(pro): assign a violation mark for every instance of tone of the verb, whose left edge does not coincide with the left edge of the domain (object pronoun + verb)

(362)

/mī tóókónnēē/ M H M	ALIGN-L(pro)	IDENT-T
i. ☞ [mí tóókónnēē] M H M		*
ii. [mī tóókónnēē] M H M	*	

The alignment restriction with pronouns concerns only the object pronoun and the verb, as the subject pronoun is intact to any tonal alternations.

7.4.4 Non-human object pronouns

The non-human direct object pronouns are **u** for singular and **ũ/ni** for plural depending on the aspect of the verb. In PFV, these pronouns are tonally H with a H-verb. With a L-verb, tone of the pronoun is realized on the M level, as presented in (363). The CV H-verb, which is realized on the M level with the affirmative particle **nā**, remains H with the object pronoun. This suggests that two underlying H tones are prominent, and thus, the effect of M tone spreading is not realized (see verb **fí**, *to buy*). The interpretation is that PFV object pronouns for non-humans are underlyingly H; in conjunction with L and M tones, they are lowered, surfacing at the M level.

(363)

	L, **mà** (*to hit*)		***Gloss***
sg	ì mò**ó** nā	[_ _– –]	*He hit it.*
sg	ì mòó bɔ̀	[_ _– _]	*He didn't hit it.*
pl	ì mà **ní** nā	[_ _ – –]	*He hit them.*
	H, **fí** (*to buy*)		
	ì fí nā	[_ – –]	*He bought.* (*without object*)
sg	ì fí**ú** nā	[_ — –]	*He bought it.*
pl	ì fí **ní** nā	[_ – – –]	*He bought them.*
	H, **céé** *(to watch)*		
sg	ì có**ó** nā	[_ — –]	*He watched it.*
sg	ì cóó bɔ̀	[_ — _]	*He did not watch it.*
pl	ì céé **ní** nā	[_ — – –]	*He watched them.*

In IPFV, if the verb is M, the direct object pronouns are realized M. They precede the verb in that case. With a HM-IPFV, the pronouns are realized H (see in (364)). Non-human object pronouns acts tonally like the human pronouns.

(364)

	M, **cēēkēē** (*to watch*)		*Gloss*
sg	ì **u** cēēkēē nā	[_ – — — –]	*He watches it.*
pl	ì **ũ** cēēkēē nā	[_ – — — –]	*He watches them.*
	HM, **fííjēē** (*to buy*)		
sg	ì **u** fííjēē nā	[_ – — — –]	*He buys it.*
pl	ì **ũ** fííjēē nā	[_ – — — –]	*He buys them.*

7.5 Chapter synthesis

7.5.1 Tonal system

Tonal melodies of nouns are stable in Samue, which is, at least partly, due to the number of tonal melodies, as discussed in 7.2.5. Some tonal alternations, however, were found. For example, with noun class suffixes and a demonstrative determiner, it is possible to see the effect of tonal spreading and fusion. Otherwise, no tonal alternations are attested with nouns.

Verbs in Samue display another kind of situation. **Only four tonal melodies were found, but the lexical tone contrast is neutralized in IPFV and FUT**. This is a common phenomenon, when tone has grammatical functions, as previously stated (e.g. Hyman & Schuh 1974) and reported also for Gur languages (e.g. Hyman & Olawsky 2004). In verb phrase, tone spreading occurs regressively from the particle leftwards. Depending on the particle in question, the spreading is bounded or unbounded. Pronouns are also partly influenced by the adjacent verb (in IPFV) or verbal particle (in PFV). Thus, tone spreading to pronouns is also regressive in Samue. In Gur languages, both L and H spreading are reported, e.g. in Dagbani (Hyman & Olawsky 2004), as well as the progressive and regressive spreading, which are both reported, for example, in Kɔnni (Cahill 2007a). However, to date, M tone spreading is not reported in other Gur languages.

In the tone system of Samue, **tone spreading in the verb system is regressive concerning the M tone**. The only spreading case with nouns occurs between the L-ending melodies, where the L tone spreads to the suffix progressively. Samue does not display downstep or polarity, neither is the OCP principle respected in Samue. Rather, the two adjacent H tones, for example, have a blocking effect on the M tone spreading. A very limited case of tone fusion is attested between the noun and the following clitic (the demonstrative determiner **nì**).

Tonal associations are sometimes prosodic in Samue, for example the first person singular object pronoun consists of a sole nasal and it is tonally associated to the preceding subject pronoun, whereas CV object pronouns are rather influenced by the following verbal tone. Samue also displays different patterns of spreading, i.e. **the spreading in the verb phrase is bounded or unbounded depending on the verbal particle in question. The spreading in both cases occurs only when the particle immediately follows the verb**. This might suggest a phonology-syntax interface in Samue. The same phenomenon is also found in verb phrases, where an object pronoun is present. When the **nā** M tone spreads to the preceding object pronoun, however, the spreading does not iterate until the verb. These spreading restrictions of different syntactic phrases will be the subject of a future study. The following summary illustrates the tonal processes found in Samue.

Table 23. Summary table of tonal processes.

Tonal process	**Context and illustration**
Nouns	
• progressive L tone spreading	from stem to suffix in L-ending noun melodies • /sìì-bé/ → [sìì-**bě**], *tree-pl*
Nouns	
• tone replacement	LH-tone in compounds (if second element is a noun) • /kɛ́ɛ́/ + /báà/ → [kɛ́ɛ́-bàá], *clinic*
• tone copying	in reduplicated words • /kulo-kùló-nú/ → [**kùló**kùlònú], *lung*
• tone fusion	with demonstrative determiner • /káálá/ + /nì/ → [káálá-**nī**], *this straw mat*
Verbs	
• tone neutralization/ tone replacement	imperfective aspect and future tense • /cá/ → [**cāā**] IPFV, [**cà**] FUT, *to offend*
• unbounded regressive M tone spreading	the M of **nā** particle spreads • /kà/ + /nā/ → [**kā** nā], *to crunch AFF*
• bounded regressive M tone spreading	the M of **ntē** particle spreads • /kpásá/ + /ntē/ → [kpá**sá** ntē], *to escape PST*
Pronouns	
• regressive M tone spreading	from **nā** particle to the pronoun • /mà/ + /bè/ + /nā/ →[mà **bē** nā], *to hit 1sg.DO AFF*

All three level tones of Samue are speficied, i.e. there is no default tone that is phonologically unspecified. The unspecification is reported for example in the case of the so called accentual tonal languages (see further discussion in 4.2.3). In Samue, all three level tones are phonological. This is proved by the fact that all level tones form contours with each other and especially the mid tone is prominent in assimilatory (spreading) processes. Furthermore, the lexical H tone is stable and some special cases of L tone spreading occurs too. The contour behavior (Hyman 2001b) and assimilatory prominence (Maddieson 1978) are mentioned as a criterion for the specified tones.

7.5.2 OT application to tonal system

The application of OT to the whole phonological system was argued to be rather feasible (see section 6.5 above). The analysis of the tonal system revealed some contradictory aspects. It was

challenging to posit OT ranking hierarchies for certain specific tonal processes, such as spreading of the M tone of past tense particle only to H-toned verbs in comparison to the spreading of the affirmative particle M tone to L-toned verbs. In addition, the moraic structure of the verb together with the lexical tone of the verb posited a difficulty for a straightforward ranking hierarchy. In other words, different cases of spreading with different verbs required different analytical approaches. At the same time, however, some high-ranked constraints proved to dominate in different domains, such as MAX(H) and *DISASSOCIATE(H) constraints, which are always higher ranked than for example NOLONGT or ONET/μ constraints.

The aim of the present study was to apply OT to a particular language without creating morpheme specific constraints, as constraints are posited to be universal in OT. In the tonal analysis, however, some constraints referred to specific morphological and grammatical entities in Samue. The Alignment and Disassociation constraints needed to be specified as regards certain particles or inflectional aspects only (e.g. constraints ALIGN-L(na) (330) and *DISASSOC(na) (351)). However, more general constraints could have been used, such as ALIGN-L(Morp), referring to any morphological phenomenon that could have been specified for the contexts where the constraint is employed. The replacement of the lexical tone by grammatical tiones in IPFV and FUT also demanded the creation of specific constraints as defined in (321) and (322). The tentative analysis of monomoraic H-verbs in conjunction with **nā** particle, when preceded by either H- or L-toned pronouns, created a situation where a new type of constraint was employed, namely MAX(H,H). MAX(H,H) requires the faithful correspondence of two adjacent tones of the same quality, and thus it is contrary to the OCP principle prohibiting identical adjacent tones. The OCP is reported to be inactive also in the Kɔnni language of Ghana (Cahill 2007a).

As discussed previously in 6.5, some of the Cahill's (2007a) arguments concerning the non-universal nature of some constraints were proved to be true in the tonal analysis of Samue, although the basic OT principles were naturally applied in the segmental analysis of the sound system. As Cahill (2007a) claims, a single tableau with specific constraints may prove the correct result, but when the constraints are applied with a larger candidate set, some other constraints might be decisive. This occurred in the analysis of bounded spreading in Samue, where the EXTENDM constraint along with MAX(H), *DISASSOC(H) and ONET/μ constraints were insufficient when applied to monomoraic verbs, although with bimoraic mono- and disyllabic verbs the ranking was proved. A reason for this might be the complexity of tonal systems in African languages as such, i.e. the problem is not necessarily linked to the theoretical approach applied in the present study.

8 CONCLUSIONS

The objective of the present study was to examine the phonological and tonal structure of the largely undescribed Gur language called Samue, spoken in Burkina Faso, West Africa. This has been achieved by investigating the consonant and vowel phonemes of the language, their acoustic realizations and their allophonic variants. In addition, the phonotactic structure of the language was examined, along with the phonological processes attested in the language. Lexical level tones were analyzed and tonal processes at the word and sentence levels were also discussed, including a description of the grammatical function of tones. These descriptive data were further investigated in the theoretical framework of the Optimality Theory, which is the theoretic innovation that returned the domain of phonology back to the center of attention in linguistic research.

The description of a previously undocumented language is the major contribution of the present study. The results presented in this study give further insights concerning the typology of the related languages, and may also give new information about areal features that the languages in the region employ. The description of the language also enables further language development in the form of orthography establishment, and thus reinforces the language community's linguistic identity. In addition to this, the analysis of the whole phonological system according to Optimality Theoretic principles provides a possibility to increase the understanding of how suitable the theory of constraints' interaction is, when applied to a whole domain of a particular language.

This conclusion chapter provides a synthesis of the main descriptive findings of the Samue sound system in relation to other Gur languages (section 8.1). The implications of the OT application in an entire language system are also discussed (section 8.2). The present study is concluded by examining the possible aspects of future research, including the limitations of the present study (section 8.3).

8.1 Typological findings

The main findings in the Samue sound and tonal structure are chapter specific and are summarized within the respective sub-sections (through chapters 6 to 7), and will not be discussed

here. Rather, the particular phenomena of Samue that do not conform to other already described Gur languages are highlighted in the present discussion.

The phonological system of Samue displays the features that are widely attested in Gur languages. This includes rather typical consonant and vowel systems. The particularities of Samue consonants are found in the remarkable lenition process of stops and of some other consonants, and the presence of the phoneme /ɾ/. Some accidental gaps are found in phonotactic structure, such as the absence of nasal consonants in front of mid vowels. Considering phonological processes, vowel harmony is also attested according to the feature [back], which is a rare phenomenon in Gur, although the ATR harmony is widely reported in Gur languages.

The 3-tone system of Samue has stable noun melodies and the regressive M tone spreading in verb phrases between the verb and the verbal particle. The M tone spreading is not reported in other Gur languages to date, and it can be considered as a particularity of the Samue tonal system. Tones in Samue do not display polarity, a tonal process which is reported to be frequent, especially in Gur languages, nor is downstep attested in Samue. The very frequently attested OCP principle is also absent in the Samue tone system, as the consequent tones at the same level are preserved and not deleted.

The sketch of the grammar revealed that the position of the direct object changes according to the aspect (imperfective or perfective). This is a particularity of Samue. Moreover, both affirmation and negation are marked by an obligatory phrase final particle, although affirmation is less marked than negation in many languages.

The hypotheses of the present study are thus largely confirmed, as the Samue language displays the patterns typically present in other Gur languages, although some minor particularities are attested.

8.2 Theoretical implications

Optimality Theory was employed as the main theoretical framework in the present study. The application of OT to a whole phonological and tonal system of a particular language proved to be realizable and the need for pure language specific constraints was minimal.

The strength of OT with its parallel nature and its method of clarifying the relationship of morphology to phonological processes was demonstrated in the present study. However, some parts of the analysis were somewhat challenging, because some basic constraints could be ranked in different ways depending on the phenomenon in question. The languages in general also display cases of variation, where the standard OT principles with ordered rankings cannot be

applied, therefore the theory of Partially Ordered Grammars was employed. This was the case for the consonantal system in Samue with voicing and lenition variation.

As argued previously, a sample of a particular language analyzed with OT principles may prove a certain ranking hierarchy for the constraints, but when the same hierarchy is applied to a larger set of candidates, or to different domains in the language, the rankings may change (e.g. Cahill 2007a). This occurred in the analysis of bounded tone spreading in Samue, where the moraic structure together with the level tones influences the spreading, and thus the constraint ranking becomes complicated. However, it is yet to be seen whether these challenges are a property of the applied theory, or of the tonal system in question. However, it has been posited that OT applications in African languages may give new theoretical insights about complex tonal phenomena (e.g. Downing 2009).

The comparative approach of OT cannot be verified, if the OT analysis has been conducted with very language specific constraints. For this reason, the constraints employed in the present study were largely those previously reported in the literature. In general, if many markedness constraints dominate faithfulness constraints, alternations occur between the phonological input and the phonetic output. This was largely confirmed within the Samue consonantal lenition, where voiceless phonemes realize as voiced or weakened to approximants. However, it is problematic to compare the constraint rankings attested in Samue to other languages in a thorough way. Some phonological processes, such as vowel coalescence and vowel harmony, are largely analyzed in different languages, and thus it was possible to compare the previously posited rankings to the situation in Samue. In some other domains, for example concerning the tone spreading, this is much more challenging, because the processes are already very language specific. Thus, the exact comparisons are more difficult to conduct, although some general tendencies do exist (i.e. H and L tone spreading is more common than M tone spreading).

The basic principle of factorial typology is that a set of constraints formally predicts all the existing patterns in the languages. However, as previously discussed, factorial typology does not predict that all possible grammars are actual languages (e.g. McCarthy 2008:235). In this sense, language specific constraints are not a real problem for the formal OT phonology. However, the effect of the addition of completely new constraints to the CON should be checked. For instance, the MAX(H,H) constraint used in the present study is antithetical in comparison with the basic OCP principle. The constraint interaction in an entire phonological domain may be very complex, and thus a minimal change may affect the ranking hierarchies, and consequently the predicted language grammars in an unexpected way (e.g. McCarthy 2008). For this reason, more OT applications to entire language systems are needed in order to have a complete picture of the factorial typology predictions that OT advocates, since it is possible to speculate that the CON is

not fully known at the present, as McCarthy (2008) argues. This holds true not only for specific language families and closely related languages, but for languages all around the world.

To conclude, it is possible to state that OT is a suitable framework for the analysis of an entire domain of a language, although it engenders complex analyses and some descriptive data may not achieve a straightforward theoretical interpretation; partly due to the complexity of the language systems (e.g. tonal processes) and partly due to the complexity of the constraint interaction.

8.3 Future research

The analysis of the phonological and tonal structure of a language is only a starting point in language description. Thus, the thorough study of the morphological and syntactic structure of Samue is a direction for the future research. At the same time, the dialectal variation in Samue is of interest, as well as a deeper study of the phonology-syntax interface in the language. Another future research strategy is to closely study related languages, such as Natioro and the Palɛni language spoken in Faniagara village. The other geographically, closely located languages belong to other sub-groups of the Gur language family.

The application of OT in the whole phonological system proved to be somewhat complicated. There is a need for more studies of this type to explore the capabilities of OT to analyze a whole linguistic system. At the same time, there are, as yet, no approved constraint sets with which certain phonological phenomena could be analyzed (e.g. assimilation or vowel harmony). When OT is applied to more language systems, it might be possible to have an agreement of constraints employed in particular processes, and thus the factorial typology principle of OT could hopefully be proved in a more comprehensive way.

The present study encountered certain number of limitations. The main limitation concerns the data collection. More diversified data and a greater amount of data could have been collected from more speakers. Furthermore, the dialectal differences were mainly beyond the scope of the present study. All these factors could be considered in any future research.

In the present study, the phonological and tonal structure of Samue was described and analyzed. The language proved to have the main characteristics of the Gur languages as regards phonological and tonal domains, although Samue and the Natioro language are unclassified in relation to other Gur languages. Future research into Samue and other Gur languages will certainly give more insights into language affinities and typological issues.

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Annex 1. Minimal pairs of consonants

	Phonetic	*Gloss*	Phonetic	Gloss
/p/ ≠ /b/	púú-nú	*acarid-sg*	búú-nú	*horn-sg*
	pàɾă	*mud, muddy ground*	bàɾă	*bat*
	pɛ̀	*to milk*	bɛ́	*to hatch out*
	pā	*to come*	bá	*to give*
/p/ ≠ /t/	pì-é	*request-sg*	tì-é	*spot-sg*
	pɛ̀	*to milk*	tɛ̄	*to crush*
	pù	*to bury*	tú	*to fill up*
	pùgò	*to tie*	túgó	*to catch (fire)*
/p/ ≠ /f/	pōó	*fruit of liana*	fōó	*spatula*
	pàɾă	*mud, muddy ground*	fārá	*sandal*
	pɛ̀	*to milk*	fɛ́	*to go out*
	púló	*to cook*	fùlò	*to close*
	pí	*to request*	fí	*to buy*
/p/ ≠ /c/	púà	*thing*	cùá	*manner*
	pí-sé	*child-pl*	cíí-sĕ	*locust-pl*
	pā	*to come*	cá	*to bark*
	pí	*to request*	cí	*to weave*
/p/ ≠ /k/	pù	*to bury*	kù	*to cut*
	pàɾă	*muddy ground*	káɾă	*hook*
	pa̰a̋	*hole*	ka̋a̰	*dry season*
/p/ ≠ /k͡p/	pàɾă	*muddy ground*	k͡pārá	*shelter*
	pa̰-a̋	*hole-sg*	k͡pā̰ā̰	*iguana*

	Phonetic	*Gloss*	Phonetic	Gloss
	pì-é	*request-sg*	k͡píè	*porcupine*
	pā	*to come*	k͡pá	*to dry*
/p/ ≠ /m/	pə̀-ə́	*hole-sg*	mə́ə̀	*liana*
	púrú-má	*stinger-pl*	múrú-sě	*monkey-pl*
	pɪ́ɪ́já	*lizard (sp)*	mɪ́ɪ́já	*voice*
	pí	*to request*	mí	*to hide*
/p/ ≠ /w/	pɪ́ɪ́já	*lizard (sp)*	wɪ́ɪ́jà	*grease, oil*
	pā	*to come*	wá	*to lock up*
	pɛ̀	*to milk*	wɛ́	*to burst*
	púló	*to cook*	wúló-ní	*to bite*
/b/ ≠ /f/	bàrə̌	*bat*	fārá	*sandal*
	bāmī	*to sew*	fàmì	*to fan*
	būlō	*to spout*	fùlò	*to close*
/b/ ≠ /s/	bū	*to remove*	sū	*to sell*
	bá-à	*house-sg*	sá-à	*rice field-sg*
	báá-ná	*bridge-sg*	sàà-nă	*sand-sg*
/b/ ≠ /m/	bá-à	*house-sg*	máá	*ground*
	bá-sí	*to help*	mà-sí	*to wake up*
	bá	*to give*	má	*to go lumpy*
	jìbì-nŭ	*pig-sg*	jìmì-nă	*moon-sg*
/b/ ≠ /w/	bá-à	*house-sg*	wá-à	*shea-sg*
	būlū-sí	*to sweet*	wúló-sí	*to carve*
	bɛ́	*to hatch out*	wɛ́	*to burst*
	bá	*to give*	wá	*to lock up*

	Phonetic	*Gloss*	Phonetic	Gloss
/b/ ≠ /k͡p/	bá-jī	*to add*	k͡pá-jī	*to divide*
	bá-à	*house-sg*	k͡páà	*dryness*
	báá-ná	*bridge-sg*	k͡pàà-nă	*portion-sg*
	bɛ́ɛ́-má	*balafon-pl*	k͡pɛ̄ɛ̄-nà	*stupid-sg (pejorative)*
/t/ ≠ /c/	tā	*to leave*	cá	*to bark*
	túà	*baobab*	cùá	*manner*
	tɔ̄ɔ̄-ná	*lunch-sg*	cɔ̄ɔ́-ná	*fish trap-sg*
	tɛ̄ɛ̄-nà	*story-sg*	cɛ̄ɛ́-ná	*ladle-sg (sp)*
/t/ ≠ /k/	tú-à	*baobab-sg*	kú-à	*river-sg*
	tà-á	*rock-sg*	káà	*baboon*
	tɔ̄ɔ̄-ná	*lunch-sg*	kɔ̄ɔ̄-ná	*left hand-sg*
	túmù-nŭ	*partridge-sg*	kúmú-nú	*tree-sg (sp)*
	tá-jī	*to deepen*	kā-jī	*to chew*
/t/ ≠ /k͡p/	tɛ́ntɛ̄ɛ̄-ná	*grasshopper-sg*	k͡pɛ́nk͡pɛ́-nă	*necklace-sg*
	tā́ā́	*root*	k͡pā́ā́	*iguana*
	tā	*to leave*	k͡pá	*to draw water*
	tá-jī	*to deepen*	k͡pá-jī	*to divide*
/t/ ≠ /s/	tɛ̄ɛ̄-nà	*story-sg*	sɛ̀ɛ̀-ná	*truth-sg*
	tā́ā́	*root*	sā́ā́	*stem, stalk*
	tū	*to bathe*	sū	*to sell*
/t/ ≠ /n/	tā́ā́	*root*	nā́ā́	*mouth*
	tu	*below (postposition)*	nu	*nearby (postposition)*
	tɔ̄ɔ̄-ná	*lunch-sg*	nɔ̄ɔ́-ná	*friend-sg (masc.)*

	Phonetic	*Gloss*	Phonetic	Gloss
	kátù-nă	*forehead-sg*	kànūū-ná	*argument-sg*
/t/ ≠ /l/	tɛ̄	*to crush*	lɛ́	*to refuse*
	tá-jī	*to deepen*	lājī	*to talk openly*
	téntɛ̄ɛ̄-má	*grasshopper-pl*	lèntɛ́-má	*basket-pl*
/c/ ≠ /k/	cáá	*rainy season*	káà	*shell*
	ấcúkúlá	*cowrie shell*	ấkúlúpí-e	*small path-sg*
	nícù-á	*crowd-sg*	nîkù-á	*cup-sg*
	cá	*to ferment*	kà	*to crunch*
	cààmì	*to smile, to laugh*	káámí	*to roll up*
/c/ ≠ /k͡p/	cáá	*rainy season*	k͡páà	*dryness*
	cāā-ná	*friend-sg (fem.)*	k͡pàà-nă	*portion-sg*
	cá	*to bark*	k͡pá	*to draw water*
	cíí-jé	*female genitals-pl*	k͡píí-jé	*man-sg (male)*
/c/ ≠ /j/	cìì-nŭ	*river bank-sg*	jíí-nú	*guinea corn-sg*
	cáá	*rainy season*	jáá	*year*
	cá	*to bark*	já	*to request*
	cù-á	*manner-sg*	jú-à	*tree-sg (sp)*
	cầ	*to dig*	jấ	*to see*
/k/ ≠ /k͡p/	kấká-ná	*side-sg (of body)*	k͡pā̋k͡pā-nà	*harmattan-sg*
	káà	*shell*	k͡páà	*dryness*
	kà	*to crunch*	k͡pá	*to dry*
	kājī	*to chew*	k͡pá-jī	*to divide*
/k͡p/ ≠ /w/	k͡píí-jé	*man-sg (male)*	wíí-jè	*roof-sg*
	k͡pá	*to draw water*	wá	*to lock up*

	Phonetic	*Gloss*	Phonetic	Gloss
	k͡páà	*dryness*	wá-à	*shea-sg*
/f/ ≠ /m/	fí	*to buy*	mí	*to hide*
	fùù-ní	*to burst*	mūnī	*to harvest*
	fùɾùkà	*to stir paste of millet or corn*	múnúkú	*to blow nose*
/f/ ≠ /s/	fĩí-nú	*donkey-sg*	sìì-nŭ	*duck-sg*
	fí	*to buy*	sí	*to be big*
	fùù	*to meet*	sū	*to sell*
/f/ ≠ /w/	fî-é	*mistake-sg*	wì-é	*sun-sg*
	fŭn-nī	*blacksmith-sg*	wùn-nĕ	*cold-pl*
	fàà	*to be numerous*	wáá	*to plough rice field*
/s/ ≠ /n/	súmú	*heart*	nú-mú	*water-pl*
	sa̋a̋	*stem, stalk*	na̋a̋	*mouth*
	sa̋pí-e	*knife-sg*	na̋pí-e	*grinding stone-sg*
	ságá	*to wash*	nágá̋	*to travel*
	k͡písí	*to finish*	k͡pìnì	*to last*
/s/ ≠ /l/	sɔ́gɔ́-má	*rubbish (pl)*	lɔ̀gɔ̀-mă	*fertilizer (pl)*
	ságă	*middle*	lágă	*fold*
	káásá	*broom*	káálá	*straw mat*
	kúsŏ	*pregnancy*	kúló	*hunger*
/m/ ≠ /n/	ma̋à̋	*liana*	na̋a̋	*mouth*
	mápí-e	*mud block-sg*	nàpì-é	*muscle-sg*
	mà	*to hit*	nā	*to miss*
	-nu	*noun class suffix, sg*	-mu	*noun class suffix, pl*

	Phonetic	*Gloss*	Phonetic	Gloss
/m/ ≠ /w/	mà	*to hit*	wà	*to lose*
	mɪ̋ɪ̋-já	*voice-sg*	wɪ̋ɪ̋-já	*robe-sg*
	mɑ́ɑ̀	*liana*	wɑ́ɑ́	*road*
	mājī	*to wring out*	wájī	*to be twisted*
/n/ ≠ /l/	námî	*to straighten up*	lāmī	*to lengthen*
	násí	*to be afraid*	là-sí	*to peel*
	nágɑ́	*to travel*	làgà	*to open mouth*
	nì	*to drink*	lí	*to kill*
/n/ ≠ /ɾ/	kànǎ	*to paddle (v)*	káɾǎ	*hook (n)*
	kɛ́nɛ̀-mǎ	*pancreas-pl*	kɛ́ɾɛ̀-bɛ̌	*bambara nut-pl*
	pú-nǎ	*dog-sg*	púɾá	*stinger*
/n/ ≠ /j/	nágɑ́	*to travel*	jágá	*to cry, to weep*
	nàmì-nǎ	*scorpion-sg*	jàmì-nǎ	*elephant-sg*
	nɑ̀̃gàà-nǎ	*heron-sg (sp)*	jɑ̀̃gá-ná	*rattle-sg*
/ l/ ≠ /ɾ /	būlū	*to spring*	būɾū	*to turn (round)*
	jìlè	*to enter (V)*	jíɾɛ̌	*hair (N)*
	būlū-sí	*to sweat*	būɾū-sí	*to be scratched*
	Pálà	*Faniagara (proper name)*	pàɾǎ	*muddy ground*
/j/ ≠ /w/	jājī	*to winnow with a basket*	wájī	*to be twisted*
	jágá	*to cry, to weep*	wàgǎ	*to stay*
	jɑ̀̃ɑ́	*benefit*	wɑ̀̃ɑ́	*fire*

Annex 2. Minimal pairs of vowels

	Phonetic	***Gloss***	**Phonetic**	***Gloss***
/i/				
/i/ ≠ /u/	pí	*to ask*	pù	*to bury*
	kísí-ná	*insect-sg (sp)*	kúsú-wa̋	*neck-sg*
	ì	*he/she, 3s human (pro)*	ù	*it, sNH (pro)*
	tímă	*blood*	tùmă	*palm rat*
/i/ ≠ /e/	líkì-mŭ	*hoe-pl*	lékè-mū	*hunter-pl*
	bílì-mŭ	*cloth-pl*	bèlè-mŭ	*sacrifice-pl*
	k͡pìsìkànă	*thin*	k͡pèsèmìnă	*sour*
	fí	*to buy*	fè	*to greet*
/i/ ≠ /ɛ/	sìkì	*to carry*	sɛ́kɛ́	*to join*
	lí	*to kill*	lɛ́	*to refuse*
	jírì-mŭ	*hair-pl*	jɛ̀rɛ̀-mă	*carp-pl*
/i/ ≠ /ii/	cí	*to weave*	cíí	*to insult*
	fí	*to buy*	fíí	*to find*
	cí-mà	*salive-pl*	cîì-mă	*woman-pl*
	cì-nă	*wood*	cìì-nŭ	*river bank*
/i/ ≠ /ĩ/	jìkò-sĕ	*cheek-pl*	jĩ́ká-sé	*fig tree-pl*
	pí-sé	*child-pl*	pĩ́-sé	*horn-pl*
	wí-á	*waterhole-sg*	wĩ̀-ã́	*leaf-sg*
	ítúú-jé	*jealousy*	ĩ́túú-jé	*blindness*
/e/				
/e/ ≠ /o/	lèké	*to hunt*	lókómí	*to be soft (fruit)*
	k͡pélékú	*to roll*	k͡pólókó	*to shell*
/e/ ≠ /ɛ/	fé-já	*he who greets-sg*	fɛ́-já	*passenger-sg*
	lèmì-ní	*to taste*	lɛ́mí-sí	*to lick*

	Phonetic	***Gloss***	**Phonetic**	***Gloss***
	k͡pēré	*to shorten*	k͡pɛ̄rɛ́	*to poison*
	bé	*I (1s pro)*	bɛ̃	*too*
/e/ ≠ /ee/	lèmì-ní	*to taste*	léémí-ní	*to light up*
	wè-mǔ	*thing-pl*	wèé-mú	*slave-pl*
/ɛ/				
/ɛ/ ≠ /ɔ/	kɛ́rɛ̀-bɛ̌	*Bambara nut-pl*	kɔ̀rɔ̀kà-á	*roughcast-sg (sp)*
	tɛ̄	*to crush*	tɔ̀	*COP*
	kɛ́nɛ̀-mǎ	*pancreas-pl*	kɔ́nì-mǎ	*cat-pl*
/ɛ/ ≠ /a/	lɛ́mí-á	*tongue-sg*	lāmī-lá	*jaw-sg*
	k͡pɛ̄rɛ́	*to poison*	k͡párámí	*to be bitter*
	lɛ́mí-sí	*to lick*	lāmīji	*to lengthen*
	lɛ̄jī	*to spread*	lājī	*to speak openly*
/ɛ/ ≠ /ɛɛ/	k͡pɛ̄-já	*big straw-sg*	k͡pɛ̄ɛ̄-nà	*stupid-sg (pejorative)*
	lɛ́mí-sí	*to lick*	lɛ̀ɛ̀kà-ní	*to stretch*
	tɛ̄	*to crush*	tɛ̄ɛ́	*to accustom*
/u/				
/u/ ≠ /o/	lù	*to put in*	lō	*to take*
	kúú-mú	*head-pl*	kóò-mǔ	*owl-pl*
	kún-nú	*family-sg*	kón-nú	*family hut-sg*
	kúrú-mú	*family-pl*	kónú-mú	*family hut-pl*
	kúsú-wǎ́	*neck-sg*	kósón-né	*rumbling-pl*
/u/≠ /ɔ/	fùgà-nǎ	*foam-sg*	fɔ̀gɔ̀-ná	*strength-sg*
	kūgú	*to moan*	kɔ́gɔ́	*to save*
	túgú-mú	*flour-pl*	tɔ́gɔ̀-mǎ	*yam-pl*
/u/ ≠ /ũ/	fúgá	*wild eggplant*	fṹgù	*to balance*
	jú-à	*tree-sg (sp)*	jṹ-à̰	*snake-sg (sp)*
	kúgù-nǎ	*louse-sg*	kṹgú-ná	*hillock-sg (yam field)*

	Phonetic	***Gloss***	**Phonetic**	***Gloss***
/u/ ≠ /uu/	tùgò-nă	*agreement-sg*	tùùgó-nú	*member of the family-sg*
	fùgà-nă	*foam-sg*	fúúgú-nú	*serpent-sg (sp)*
	pù-nŭ	*goat-sg*	púú-nú	*acarid-sg (insect sp)*
	pù	*to bury*	púú	*to urinate*
/o/				
/o/ ≠ /ɔ/	cómí	*to winnow (with a basket)*	cɔ́mí	*to stab*
	lōgō-sé	*chain-pl*	lɔ̀gɔ̀-mă	*fertilizer-pl*
	fo̍̀gó-nú	*camping-sg*	fɔ̀gɔ̀-ná	*strength-sg*
	wúló-mú	*breast-pl*	wūlɔ̄-má	*evening-pl*
/o/ ≠ /oo/	lōgō-sé	*chain-pl*	póógó-sĕ	*caterpillar-pl*
	tóò-nă	*village-sg*	tonu	*every (pro)*
/ɔ/				
/ɔ/ ≠ /a/	fɔ́gɔ̀-nă	*basin-sg*	fágà-nă	*manner-sg*
	jɔ́gɔ́	*to jump*	jágá	*to cry*
	wɔ̀ná	*to eat*	wàná	*to cook*
/ɔ/ ≠ /ɔɔ/	kɔ́nì-mă	*cat-pl*	kɔ̀ɔ̀là-mă	*cough-pl*
	kɔ́sɔ́mí	*to ruin*	kɔ̀ɔ̀gɔ̀ní	*to weed*
/a/				
/a/ ≠ /ã/	jágá-má	*cry-pl*	jã̀gá-má	*rattle-pl*
	nágà-nă	*rat-sg*	nã̀gà-nă	*bird-sg (sp)*
	ságá	*to wash*	sã̀gã̀	*to grow up*
/a/ ≠ /aa/	tàgù	*to fold*	táágá	*to approach*
	wá	*to lock up*	wáá	*to plough rice field*
	bá-má	*that who gives-pl*	báá-má	*bridge-pl*
	lágă	*fold*	láágă	*rice field plot*

	Phonetic	***Gloss***	**Phonetic**	***Gloss***
Nasal vowels				
/ĩ/ ≠ /ũ/	wḯgí	*to boil*	wṹgú	*to defecate*
	pḯcà-nā	*instrument-sg (sp)*	pṹcā-nĭ	*ancestor-sg*
	tl̃té	*instrument (sp)*	tl̃tá	*wasp*
/ũ/ ≠ /ã/	sṹgá	*to wake up early*	sl̃gl̃	*to grow up*
	tl̃tá	*wasp*	tátá-né	*mold-pl*
/ĩ/ ≠ /ã/	sl̃sé	*shame*	sl̃sé-nú	*needle-sg*
	kpḯkpí-ná	*small calabash-sg*	kpl̃kpā-nă	*harmattan wind-sg*
Long vowels				
/ii/ ≠ /ee/	fíí-mú	*donkey-pl*	fèè-mŭ	*greeting-pl*
	cîké-nú	*couscous-sg*	céékén-né	*play-pl*
/ii/ ≠ /ɛɛ/	cìì-nŭ	*rice field edge-sg*	cɛ̄ɛ́-ná	*spatula-sg (sp)*
	sìì-nŭ	*duck-sg*	sɛ̀ɛ̀-ná	*truth-sg*
/ii/ ≠ /uu/	pììmà	*to be moody*	púúmá	*to raise*
	fíí-nú	*donkey-sg*	fùú-ná	*peanut-sg*
	fíí	*to find*	fúú	*to lose*
/ee/ ≠ /ɛɛ/	fèè-mŭ	*greeting-pl*	fɛ́ɛ́-má	*passenger-pl*
	béé-mú	*stool-pl*	bɛ́ɛ́-má	*balafon-pl*
/ee/ ≠ /oo/	fèé	*greeting*	fōó	*spatula*
	tééní	*to be abundant*	tóókó	*to send*
/ɛɛ/ ≠ /oo/	kpɛ̄ɛ̄-nà	*stupid-sg*	kpóò-nŭ	*bird-sg (sp)*
	bɛ́ɛ́-má	*balafon-pl*	pōō-wé	*fruit-pl (sp)*
/ɛɛ/ ≠ /aa/	cɛ̄ɛ́-ná	*spatula-sg (sp)*	cāā-ná	*friend-sg (fem)*
	bɛ́ɛ́-má	*balafon-pl*	báá-ná	*bridge-sg*
	sɛ̀ɛ̀-ná	*truth-sg*	sàà-nă	*sand-sg*

	Phonetic	*Gloss*	Phonetic	*Gloss*
/ɛɛ/ ≠ /ɔɔ/	bɛ́ɛ́-má	*balafon-pl*	bɔ́ɔ́-ná	*person of the same age-sg*
	tɛ̄ɛ̄-nà	*story-sg*	tɔ́ɔ̀-nă	*group-sg*
	cɛ̄ɛ́-ná	*spatula-sg (sp)*	cɔ̄ɔ́-ná	*fish trap-sg*
/uu/ ≠ /oo/	kúú-mú	*head-pl*	kóò-mŭ	*owl-pl*
	púú-mú	*insect-pl (sp)*	pōō-wé	*fruit-pl (sp)*
/oo/ ≠ /ɔɔ/	kóò-mŭ	*owl-pl*	kɔ̄ɔ̄-má	*left hand-pl*
	k͡póò-nŭ	*bird-sp*	k͡pɔ́ɔ̀-nă	*respect-sg*
/ɔɔ/ ≠ /aa/	cɔ̄ɔ́-ná	*fish trap-sg*	cāā-ná	*friend-sg (fem)*
	bɔ́ɔ́-ná	*person of the same age-sg*	báá-ná	*bridge-sg*
Long nasal vowels				
/aa/ ≠ /ãã/	sáà	*rice field*	sa̋a̋	*stalk*
	càá	*to go in*	cà̋a̋	*to dig*
	jáá	*year*	ja̋a̋	*profit*
/ii/ ≠ /ĩĩ/	wíí-jè	*straw-sg*	wi̋i̋-jà	*fat/oil-pl*
	pííkù-mŭ	*hearth-pl*	pì̗ĩ̀jà-sé	*lizard-pl (sp)*
/uu ≠ ũũ/	túú-wá	*liver-sg*	tűű-já	*termite-sg*
	súú-já	*seller-sg*	sűṳ̀-wě	*fly-sg*
Long nasals vowels in contrast with short nasal vowels				
/ĩ ≠ ĩĩ/	wì̗-a̋	*leaf-sg*	wi̋i̋-já	*rope-sg*
	tĩ̀té	*instrument (sp)*	tĩ̋ĩ́já	*termite*
	pi̋cà-mā	*instrument-pl (sp)*	pì̗ĩ̀já-sé	*lizard-pl (sp)*
/ũ ≠ ũũ/	jṳ̋-à̰	*snake-sg (sp)*	jṳ̀ṳ̀-ná	*village entrance-sg*
	súú-mú	*food-pl*	sűṳ̀-wě	*fly-sg*

	Phonetic	***Gloss***	**Phonetic**	***Gloss***
/ã ≠ ãã/	sə̀sé-nú	*needle-sg*	sə́ə́-sé	*stalk-pl*
	jə̀gá-ná	*rattle-sg*	jə̀ə̀gá-ná	*stick-sg*

Annex 3. Tonal minimal pairs of nouns

Noun	**Tone melody**	***Gloss***	**Plural**	**Tone melody**
bāá	MH	*sheep*	bāámá	MH
báà	HL	*house, hut*	bɔ́ɔ̀mă	HL
bááná	H	*bridge*	báámá	H
bàànă	L	*small furrow*	bààmă	L
bàră	L	*bat*	bàràbɛ̆	L
bárà	HL	*tree (sp)*	báràbɛ̆	HL
bóókò	HL	*village*	bóókòsĕ	HL
bòòkó	LH	*second*		
cínǎ	HL	*saliva*	címă	HL
cìnǎ	L	*wood*	cìmă	L
fárà	HL	*skin*	fáràbɛ̆	HL
fārá	MH	*shoe*	fārábɛ́	MH
fóó	H	*ashes*	fóómú	H
fōó	MH	*spatula*	fōómú	MH
fɔ̀kɔ̀nă	L	*strength*	fɔ̀kɔ̀mă	L
fɔ́kɔ̀nă	HL	*basin*	fɔ́kɔ̀mă	HL
fùùnă	L	*stomach*	fùùmă	L
fúùnă	HL	*axe*	fúùmă	HL
fùúná	LH	*peanut*	fùúmá	LH
jíínú	H	*small millet*	**jíímú**	H
		urine	**jíímú**	HL
jínnáá	H	*tooth*	jíɾíbɛ́	H
jínnáá	H	*name*	jínsé	H
jínnàá	HL	*spice (sp)*		
kààkànă	L	*insect (sp)*	**kààkàmă**	L
káákà	HL	*tortoise*	**káákàmă**	HL
kànné	LH	*punishment*		

Noun	**Tone melody**	***Gloss***	**Plural**	**Tone melody**
kànnĕ	L	*scarification*		
kóò	HL	*owl*	kóòmŭ	HL
kóó	H	*head*	kúúmú	H
kɔ̀nná	LH	*cithara*	kɔ̀nìmá	LH
kɔ̂nnă	HL	*cat*	kɔ́nìmă	HL
kɔ̄ká	M	*plant (sp)*	kɔ̄kɔ̄bɛ́	M
kɔ́kà	HL	*safety*		
kpāā	M	*tree (sp)*		
kpáà	HL	*friend of elderly*	kpáàjĕ	HL
kpáá	HL	*dryness*	kpáàmă	HL
kpáá	H	*funerals*	kúúmá	H
kpàànă	L	*portion*	kpààmă	L
kpáànă	HL	*shelter*	kpáàmă	HL
kúà	HL	*lake*	kúòmă	HL
kūá	MH	*enemy*	kūómá	MH
kúá	H	*core*	kúúmá	H
kùá	L	*calabash*	kùùmă	L
kúá	H	*market*	kúúmá	H
kúsúwā́	H	*neck*	kúsúsé	H
kúsàwā̌	HL	*egg*	kúsùbĕ	HL
lóónú	H	*fishing rod*	lóómú	H
lóònŭ	HL	*mask*	lóòmŭ	HL
lùbéné	LH	*vulture*	lùbésé	LH
lùbènŭ	L	*smell*	lùbèsĕ	L
nàmìnă	L	*scorpion*	nàmìsĕ	L
námíná	H	*stack*	námísé	H
		water	**númú**	H
		gruel	**nùmŭ**	L
sáà	HL	*rice field*	sáàbĕ	HL

Noun	**Tone melody**	***Gloss***	**Plural**	**Tone melody**
sāā	M	*tree (sp)*	sāābɛ́	M
síínú	H	*body*	síímú	H
sììnŭ	L	*duck*	sììmŭ	L
tònkònŭ	L	*hump*	tònkòmŭ	L
tònkónú	LH	*funeral instrument*	tònkómú	LH
tɔ́ɔ̀nă	HL	*group*	tɔ́ɔ̀mă	HL
tɔ̄ɔ̄ná	M	*lunch*	**tɔ̄ɔ̄**má	M
wa̰á̰	LH	*fire*	wa̰a̰bɛ̆	L
wáá́	H	*road*	wáá́sé	H
wáà	HL	*shea*	wáàbɛ̆	HL
wāā	M	*rubber tree*	wɔ̄ɔ̄bɛ́	M
wḭijà	HL	*oil, fat*	wḭijɛ̀	HL
wííjá	H	*rope*	wíísé	H

Annex 4. Realization of noun melodies in the object position (verb in IPFV and in FUT).

H-melodies

	Object + verb **M-IPFV** *He looks at X* **ì X cēēkēē nā** [_ X —— –]	**Object + verb** **H-IPFV** *He buys X* **ì X fííjēē nā** [_ X ¯— –]	**Object + verb** **L-FUT in NEG** *He won't watch X* **ìì X pɛ̀ɛ̀kà bɔ̀** [__ X __ _ _]
H			
kaala (*straw mat*)	i **kaalɔɔ** ceekee na [_ ¯¯ —— –]	i **kaalɔɔ** fiijee na [_ ¯¯ ¯— –]	ii **kaalɔɔ** pɛɛka bɔ [__ ¯¯ __ _ _]
HL			
kpaana (*shelter*)	i **kpaanɔɔ** ceekee na [_ \ ⁄ —— –]	i **kpaanɔɔ** fiijee na [_ \ __ ¯— –]	ii **kpaanɔɔ** pɛɛka bɔ [__ \ ⁄ __ _ _]
kaaka (*tortoise*)	i **kaakɔɔ** ceekee na [_ ¯ ⁄ —— –]	i **kaakɔɔ** fiijee na [_ ¯ __ ¯— –]	ii **kaakɔɔ** pɛɛka bɔ [__ ¯— __ _]
HM			
kãkã (*ant* sp)	i **kãkɔ̃ɔ̃** ceekee na [_ ¯ ⁄ —— –]	i **kãkɔ̃ɔ̃** fiijee na [_ ¯ ⁄ ¯— –]	ii **kãkɔ̃ɔ̃** pɛɛka bɔ [__ ¯— __ _]
tɛntɛɛna (*grasshopper*)	i **tɛntɛɛnɔɔ** ceekee na [_ ¯ —¯ —— –]	i **tɛntɛɛnɔɔ** fiijee na [_ ¯ —¯ ¯— –]	ii **tɛntɛɛnɔɔ** pɛɛka bɔ [_ ¯ —¯ __ _]
HM			
ciibɛ (*woman*)	i **ciibee** ceekee na [_ \ ⁄ —— –]	i **ciibee** fiijee na [_ \ ⁄ ¯— –]	ii **ciibee** pɛɛka bɔ [__ \ — __ _]
HLH			
cafaana (*pocket*)	i **cafaanɔɔ** ceekee na [_ ¯ ⁄ ¯ —— –]	i **cafaanɔɔ** fiijee na [_ ¯ ⁄ ¯ ¯— –]	ii **cafaanɔɔ** pɛɛka bɔ [__ ¯ ⁄ ¯ __ _]

M-melodies

	Object + verb **M-IPFV** *He looks at X* **ì X cēēkēē nā** [_ X — — –]	**Object + verb** **H-IPFV** *He buys X* **ì X fííjēē nā** [_ X ¯ — –]	**Object + verb** **L-FUT in NEG** *He won't watch X* **ìì X pɛ̀ɛ̀kà bɔ̀** [__ X __ _ _]
M kpārá (*plant* sp)	i **kparɔɔ** ceekee na [_ – ¯ — — –]	i **kparɔɔ** fiijee na [_ – ¯ ¯ — –]	ii **kparɔɔ** pɛɛka bɔ [__ – ¯ __ _]
MH fíínú (*donkey*)	i **fiinuu** ceekee na [_ ˊ ¯ — — –]	i **fiinuu** fiijee na [_ ˊ ¯ ¯ — –]	ii **fiinuu** pɛɛka bɔ [__ ˊ ¯ __ _ _]
ML tɛ̄ɛ̄nà (*story*)	i **tɛɛnɔɔ** ceekee na [_ — ˋ — — –]	i **tɛɛnɔɔ** fiijee na [_ — ˋ ¯ — –]	ii **tɛɛnɔɔ** pɛɛka bɔ [__ — ˋ __ _]
ML kpɛ̄nkpà̄ (*bile*)	ì **kpɛnkpɔɔ** ceekee na [_ – ˆ — — –]	i **kpɛnkpɔɔ** fiijee na [_ – ˆ ¯ — –]	ii **kpɛnkpɔɔ** pɛɛka bɔ [__ – ˆ __ _]

L-melodies

	Object + verb **M-IPFV** *He looks at X* **ì X cēēkēē nā** [_ X — — –]	**Object + verb** **H-IPFV** *He buys X* **ì X fííjēē nā** [_ X ¯ — –]	**Object + verb** **L-FUT in NEG** *He won't watch X* **ìì X pɛ̀ɛ̀kà bɔ̀** [_ X _ _ _]
L			
kanijã	i **kanijɔ̃ɔ̃** ceekee na	i **kanijɔ̃ɔ̃** fiijee na	ii **kanijɔ̃ɔ̃** pɛɛka bɔ
(*guinea fowl*)	[_ _ _ ⟋ — — –]	[_ _ _ _ ¯ — –]	[_ _ _ ⟋ _ _ _]
LH			
fuuna	i **fuunɔɔ** ceekee na	i **fuunɔɔ** fiijee na	ii **fuunɔɔ** pɛɛka bɔ
(*peanut*)	[_ ⟋ ¯ — — –]	[_ ⟋ ¯ ¯ — –]	[_ ⟋ ¯ _ _ _]
lɛnta	i **lɛntɔɔ** ceekee na	i **lɛntɔɔ** fiijee na	ii **lɛntɔɔ** pɛɛka bɔ
(*basket*)	[_ _ ¯ — — –]	[_ _ ¯ ¯ — –]	[_ _ ¯ _ _ _]
LML			
kaloona	i **kaloonɔɔ** ceekee na	i **kaloonɔɔ** fiijee na	ii **kaloonɔɔ** pɛɛka bɔ
(*fish* sp)	[_ _ ⟍ _ — — –]	[_ _ ⟍ _ ¯ — –]	[_ _ ⟍ ⟋ _ _ _]
LM(H)			
butɛna	i **butɛnɔɔ** ceekee na	i **butɛnɔɔ** fiijee na	ii **butɛnɔɔ** pɛɛka bɔ
(*big sack*)	[_ _ - ¯ — — –]	[_ _ - ¯ ¯ — –]	[_ _ - ¯ _ _ _]

Annex 5. Realization of noun melodies in object position when the verb is in PFV

Illustrations with H, M and L verbal tones

H-melodies

	V H-PFV AFF *He looked at X* **ì céé X nā** [_ ¯ X –]	V M-PFV AFF *He took X* **ì lōō X nā** [_ — X –]	V L-PFV AFF *He brought X* **ì lù X nā** [_ _ X –]
H kaala (*straw mat*)	i cee kaala na [_ ¯ ¯⁻ –]	i loo kaala na [_ — ¯⁻ –]	i lu kaala na [_ _ ¯⁻ –]
HL kpaana (*shelter*)	i cee kpaana na [_ ¯ _ –]	i loo kpaana na [_ — _ –]	i lu kpaana na [_ _ _ –]
kaaka (*tortoise*)	i cee kaaka na [_ ¯ ¯_ –]	i loo kaaka na [_ — ¯_ –]	i lu kaaka na [_ _ ¯_ –]
HM kãkã (*ant* sp)	i cee kãkã na [_ ¯ ⁻/ –]	i loo kãkã na [_ — ⁻/ –]	i lu kãkã na [_ _ ⁻/ –]
tɛntɛɛna (*grasshopper*)	i cee tɛntɛɛna na [_ ¯ ⁻—⁻ –]	i loo tɛntɛɛna na [_ — ⁻—⁻ –]	i lu tɛntɛɛna na [_ _ ⁻—⁻ –]
HM ciibɛ (*woman*)	i cee ciibɛ na [_ ¯ \/ –]	i loo ciibɛ na [_ — \/ –]	i lu ciibɛ na [_ _ \/ –]
HLH-H cafaana (*pocket*)	i cee cafaana na [_ ¯ ⁻/⁻ –]	i loo cafaana na [_ — ⁻/⁻ –]	i lu cafaana na [_ _ ⁻/⁻ –]

M-melodies

	V H-PFV AFF *He looked at X* **ì céé X nā** [_ ‾ X –]	V M-PFV AFF *He took X* **ì lōō X nā** [_ — X –]	V L-PFV AFF *He brought X* **ì lù X nā** [_ _ X –]
M kpārá (*stretcher*)	i cee **kpara** na [_ ‾ –‾ –]	i loo **kpara** na [_ — –‾ –]	i lu **kpara** na [_ _ –‾ –]
MH fiínú (*donkey*)	i cee **fiinu** na [_ ‾ ⟋‾ –]	i loo **fiinu** na [_ — ⟋‾ –]	i lu **fiinu** na [_ _ ⟋‾ –]
ML kasiana (*nimier*)	i cee kasiana na [_ ‾ – –⟋ –]	i loo kasiana na [_ — – –⟋ –]	i lu kasiana na [_ _ – –_ –]

L-melodies

	V H-PFV AFF *He looked at X* **ì céé X nā** [_ ¯ X –]	V M-PFV AFF *He took X* **ì lōō X nā** [_ — X –]	V L-PFV AFF *He brought X* **ì lù X nā** [_ _ X –]
L kanijã (*guinea fowl)*	i cee kanijã na [_ ¯ _ _ ⸝ –]	i loo kanijã na [_ — _ _ ⸝ –]	i lu kanijã na [_ _ _ _ ⸝ –]
LH lɛnta (*basket)*	i cee lɛnta na [_ ¯ _ ¯ –]	i loo lɛnta na [_ — _ ¯ –]	i lu lɛnta na [_ _ _ ¯ –]
LH fuuna (*peanut)*	i cee fuuna na [_ ¯ ⁄ ¯ –]	i loo fuuna na [_ — ⁄ ¯ –]	i lu fuuna na [_ _ ⁄ ¯ –]
LML kaloona (*fish* sp)	i cee kaloona na [_ ¯ _ ⸜ ⸝ –]	i loo kaloona na [_ — _ ⸜ ⸝ –]	i lu kaloona na [_ _ _ ⸜ ⸝ –]
LM(H) butɛna (*big sack*)	i cee butɛna na [_ ¯ _ – ¯ –]	i loo butɛna na [_ — _ – ¯ –]	i lu butɛna na [_ _ _ – ¯ –]

Annex 6. Different tonal melodies in associative phrase.

Dependent	Melody	Head noun	Melody	Noun phrase	*Gloss*
bɔɔna (*classmate*)	H	tumuna (*beard*)	H	bɔɔnɛɛ tumuna [— — ˗˗˗]	*classmate's beard*
bɔɔna (*classmate*)	H	fiinu (*donkey*)	MH	bɔɔna i fiinu [bɔɔnɛɛ fiinu] [— — ˗/]	*classmate's donkey*
bɔɔna (*classmate*)	H	kaloona (*carp* sp)	LML	bɔɔna i kaloona [bɔɔnɛɛ kaloona] [— — _\/]	*classmate's carp*
bɔɔna (*classmate*)	H	butɛna (*big sack*)	LM(H)	bɔɔna i butɛna [bɔɔnɛɛ butɛna] [— — _˗˗]	*classmate's sack*
sia (*big brother*)	HL	tumuna (*beard*)	H	sia i tumuna [siɛɛ tumuna] [\ ˗˗˗]	*big brother's beard*
kpiese (*porcupine*)	HL	baa (*house*)	HL	kpiese n bɔɔma [kpiese n bɔɔma] [—_ \/]	*porcupines' lairs*
kua (*river*)	HL	tũtumu (*leeches*)	HM	kua u tũtumu [kuɔɔ tũtumu] [\ ˗_˗]	*leeches' river*
sia (*big brother*)	HL	kpɛnkpa (*bile*)	ML	sia i kpɛnkpa [siɛɛ kpɛnkpa] [\ ˗\]	*big brother's bile*
sia (*big brother*)	HL	fuuna (*stomach*)	L	sia i fuuna [siɛɛ fuuna] [\ _/]	*big brother's stomach*
kãkãma (*flying ants*)	HM	wãã (*road*)	H	kãkama n wãã [kãkama n wãã] [˗_˗ —]	*ants' road*
caana (*friend*)	M	baama (*sheep*)	M	caana i baama [caanɛɛ baama] [— — —˗] [/ \/]	*friend's sheep*
nɔɔna (*friend*)	MH	ciibɛ (*woman*)	HM(L)	nɔɔna i ciibɛ [nɔɔnɛɛ ciibɛ]	*friend's wife*