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**ASPECTS OF PHONETICS, PHONOLOGY AND
MORPHOPHONOLOGY OF THOK REEL.**

6674640

DECLARATION

I have read and understood The University of Edinburgh guidelines on Plagiarism and declare that this written dissertation is all my own work except where I indicate otherwise by proper use of quotes and references.

ABSTRACT

This dissertation presents the first descriptive study of a hitherto undocumented Western Nilotic language Thok Reel. The language is spoken in Southern Sudan by a minority ethnic group known as Atuot.

The study presents a descriptive account of Thok Reel phonetics, phonology and morphophonology. The description follows the topics on word and syllable structure, consonants, vowels, and tone. Each section accounts for the phonological distinctions and provides the phonetic description of the phenomena that is either typologically unusual or deviates from what is attested in related languages.

Thok Reel is a predominantly monosyllabic language with rich morphology. Morphological inflection to a large extent is expressed by means of alternations of phonological material on the monosyllabic roots. The description of morphophonology provides an account of the alternations in vowel quality, voice quality, vowel length and root-final consonants. The description is restricted to subject agreement marking in finite transitive and antipassive verbs in simple declarative sentences. The findings of this study show that there is more complexity in transitive verbs than in antipassive verbs with respect to vowel length alternations, and that transitive verbs show simpler behaviour than the antipassive with respect to voice and vowel quality alternations. Thok Reel shows more complexity with respect to vowel length alternations than is attested in related languages. One of the important findings of this study is that in Thok Reel the three levels of vowel length can be lexical.

The description of the tone system consists of phonetic and phonological accounts. The three tonemes High (H), Low (L) and High-Low (HL) are realised within a narrow frequency range and are distinguished almost solely by f₀ alignment (pitch movements). The HL tone is typologically unusual in that, although there is evidence for it being a composite tone, it does not always behave as is expected of a tone composed of H and L components. In sentences, tone sandhi processes and a contextual modification alter the phonological status of the two tonemes H and HL. The ordering of these processes varies at different levels of derivation, described as phrase-level and sentence-level. The onset of sandhi and its direction in sentences with finite transitive verbs is shown to deviate from the common pattern found in sentences with other types of verbs. It is argued that in sentences with finite transitive verbs tone sandhi is used by syntax to mark the juncture between the verb and its object.

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ABBREVIATIONS AND SPECIAL CHARACTERS

Glossing conventions follow Leipzig Glossing Rules

(http://www.eva.mpg.de/lingua/pdf/LGR09_02_23.pdf), version of February 2008.

A2	harmonic most boosted by the second formant (F2)	VOT	voice onset time
		1, 2, 3	1st, 2nd, 3rd person
ACC	accusative	1PL.INCL	‘we’ including the addressee
AP	antipassive verb	1PL.EXCL	‘we’ excluding the addressee
ATR	advanced tongue root	H (á)	High tone
ATTR	attributive	HL (â)	falling contour tone (High-Low)
C	consonant	L (à)	Low tone
DECL	declarative	T	tone
f0	fundamental frequency	V	short vowel
F1	first formant	VV	mid vowel
F2	second formant	VVV	long vowel
F3	third formant	(V)	suffix vowel: optionally realised
GEN	genitive	→	“becomes” is synchronic rule
H1	first harmonic	*	ungrammatical form
H2	second harmonic	.	in glosses: one-to-many
ISOL	(isolation) citation form		correspondences
	context		in tone notations: syllable break
LOC	locative	\	in glosses: morphophonological
NEG	negation		change
NOM	nominative	#	utterance boundary
PASS	passive	(ə)	breathy voice
PET	centripetal	(a)	modal voice
PRED	predicative	[]	phonetic representation
PST	past tense	{ }	structural (underlying)
PL	plural		representation (also left
R	repetitive		unmarked)
RED	reduplication	//	phonological representation
SG	singular	< >	orthographic representation
SM	subject marker	<	is less than (x < y, x is less
TRANS	transitive (marking	>	than y)
	transitive infinitive stems		is greater than (x > y, x is
	in glosses; finite transitive		greater than y)
	stems are left unmarked in		
	glosses)		

USER GUIDE TO TRANSCRIPTION

All phonetic characters in transcription follow the IPA standards.

Length of vowels is represented by single (a), double (aa) and triple (aaa) characters.

Likewise, geminate consonants are represented by two letters.

Diacritics are employed to mark breathy voice quality (ᵛ) and tone (á) High, (à) Low, and (â) High-Low. They are placed under and above the vowel symbols, but only under and above the first vowel symbol in a maximally three vowel symbol string. For example, the syllable tᵛéet is high toned (´), and the long vowel is breathy voiced as is evident from the diacritic marks above and under the first vowel symbol.

1. INTRODUCTION

Thok Reel is a hitherto undocumented Western Nilotic language of Southern Sudan. This thesis presents the first descriptive account of the language. The dissertation is submitted to the department of Linguistic and English Language, the University of Edinburgh, in fulfilment of the requirements for the degree of Master of Science by Research. It is based on a year-long research project that included two data collection trips to Southern Sudan. This study constitutes the first part of a four year project that is aimed to describe and to document the language.

The aim of this thesis is to give a description of the phonological distinctions and their phonetic realisations, and to present a descriptive analysis of morphophonology. The descriptive account, therefore, is a combination of selected topics in phonetics, phonology and morphophonology of Thok Reel. This might seem like a broad stretch for a descriptive account based on a year of research, however, in Thok Reel these aspects of the language system are interrelated. To understand why, consider the singular-plural pairs of nouns in (1). In these examples, morphological inflection is expressed solely by means of the alternations of the phonological material on the monosyllabic roots: modal vs. breathy voice quality in (1a), High vs. Low tone in (1b), and short (V) vs. long (VVV) vowel in (1c).

- (1) a. r̀òòk ‘molar.tooth\SG\NOM’ ~ r̀òòk ‘molar.tooth\PL\NOM’
 b. c̀ów ‘husband\SG\NOM’ ~ c̀òw ‘husband\PL\NOM’
 c. g̀àT ‘child\SG\NOM’ ~ g̀àaaT ‘child\PL\NOM’

The changes in (1) involve the alternations of the suprasegmental parameters. Other alternations involve segmental alternations (the terminal consonants and vowel quality of the root vowels), as well as the combinations of various segmental and suprasegmental alternations.

In Thok Reel syllables, the segmental and suprasegmental distinctions combine fairly independently. This presents a great challenge when it comes to transcribing every individual word. For example, the laryngeal articulators involved in the production of tone are also employed in the production of voice quality distinctions. Thus, a given pitch level may be perceived differently in syllables with breathy voiced and with modal voiced vowels. A big part of transcribing the language, therefore, involves investigations into the phonetic realisations of the distinctions in various contexts. For this reason, each section of this thesis will contain phonetic descriptions. In particular, acoustic data will be presented in support of my analysis of the phenomena that calls for a more objective perspective than what my subjective perception could grant.

The investigation into the morphophonology of the language presents another challenge: a fair amount of irregularity in the ways that the morphological distinctions are marked. This is especially true of nouns which show a highly irregular morphological behaviour. Verbs in Thok Reel behave more systematically which makes them more suitable for the initial stages of analysis. My analysis of vowel quality, voice quality and vowel length alternations, therefore, is built entirely on the verb data.

For the analysis of tone, nouns are more suitable than verbs. This is because nouns can be easily substituted into a number of contexts whereas the position of verbs in sentences is relatively fixed. Being able to substitute words into different contexts is important for studying tonal processes such as tonal allophony and tone sandhi. The analysis of the tone system in Thok Reel presents another great challenge. This is due to three reasons. First, the contrastive pitch levels are realised within a narrow frequency range which makes it difficult to tell the tonemes apart. Second, for every surface pattern in phrases and sentences there is an availability of morphological, phonological and allophonic interpretations. Third, the order of the application and the direction of the tonal processes varies in different syntactic constructions. In the section on tone I will present a descriptive analysis of phonetics and phonology, and highlight the methodological and the analytical challenges that the tone system of Thok Reel presents.

Some of the phenomena outlined above and presented in detail in the sections of this thesis, is typologically unusual (e.g. unusually rich suprasegmental system, independent combinations of the suprasegmental distinctions, stem-internal morphology). Thok Reel, however, is not unique in these respects, and much of the phenomena that will be described for Thok Reel is also attested in some other Western Nilotic languages such as Dinka (Andersen 1987, 1990, 1993, Remijsen & Gilley 2008, Remijsen & Ladd 2008; Ladd, Remijsen & Manyang 2009 and Remijsen & Manyang 2009), Nuer (Crazzolara 1933, Frank 1999), and Shilluk (Gilley 1992, 2000, Miller 2008, Reid 2009). Whenever possible my findings on phonetics, phonology, and morphophonology of Thok Reel will be compared with the findings of some of these studies.

The current study raises more questions than it gives answers. Such is the nature of a work in progress, which is exactly what I consider this thesis to be. The questions will be flagged in the thesis in the form of suggestions for the data collection during my upcoming field trip to Southern Sudan.

The study presented here is structured as follows. In the rest of this section I will give some background information on the language and its speakers. In section 2 I will present some general information on data collection and analysis. In section 3 I will present an outline of word and syllable structure. In sections 4 and 5 I will give descriptive accounts of phonetics, phonology and morphophonology of consonants and vowels, respectively; and in section 6 I will present a descriptive account of phonetics and phonology of tone.

1.1. Geographical location

Thok Reel is spoken in the Yirol West county of Lakes State of Southern Sudan (Figure 1). Lakes is the fourth most populous state of Southern Sudan. The state's capital is Rumbek, which is about 75 miles west of the Yirol West. Major cities in Yirol West are Yirol (north-east) and Mapuordit (south-west).

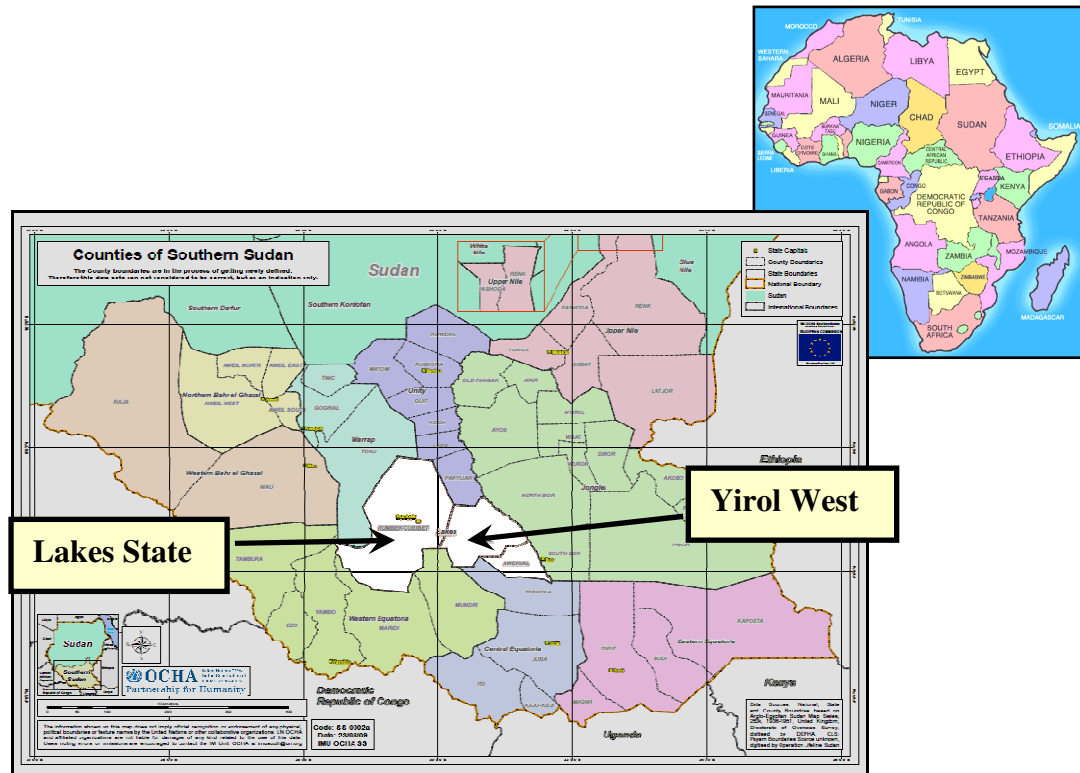


Figure 1. Map of Southern Sudan.

1.2. Language background

Thok Reel is a Western Nilotic language of Dinka-Nuer subgroup. This subgroup comprises of the three languages: Dinka, Nuer and Thok Reel. The speakers of Dinka are the most numerous group with some 1.5 million native speakers. The speakers of Nuer are the next biggest group with some 740,000 native speakers. Thok Reel is spoken by the relative minority group approximated as 50,000 people. The figures

given here come from Ethnologue (Gordon 2005). It is impossible to verify them with any accuracy and there exist other accounts that suggest higher figures. For example, Remijnsen & Manyang (2009) cite the number of Dinka speakers as over 2 million. Similarly, during 2008 census 94,481 people were registered at the four payams (administrative centres) of Yirol West where the majority of the population are the native speakers of Thok Reel (Telar Deng, p.c.).

The speakers of Thok Reel are thought to be a Nuer section which migrated into the Dinka territory some 500 years ago (Burton 1987). As a matter of curiosity, the Thok Reel word for ‘human (person)’ is nwêëer, whereas in Nuer and Dinka a cognate raaan (Dinka) ~ raan (Nuer) is used.¹

Figure 2 shows the geographical location of Thok Reel and the neighbouring languages. A closely related Western Nilotic language Dinka is spoken at the northern, north-western and north-eastern frontiers of the Thok Reel speaking area. The rest of the neighbouring languages do not belong to a Western Nilotic group: Beli (Bongo-Bagirmi) is spoken at the south-western frontier, and Moru (Moru-Madi) and Mundari (Eastern Nilotic) are spoken at the southern frontier.

¹ Dinka transcription cited in 400 nouns data set from Ladd, Remijnsen & Manyang (2009), Nuer transcription cited in Vandevort [<http://www.dlib.indiana.edu/collections/nuer/>].

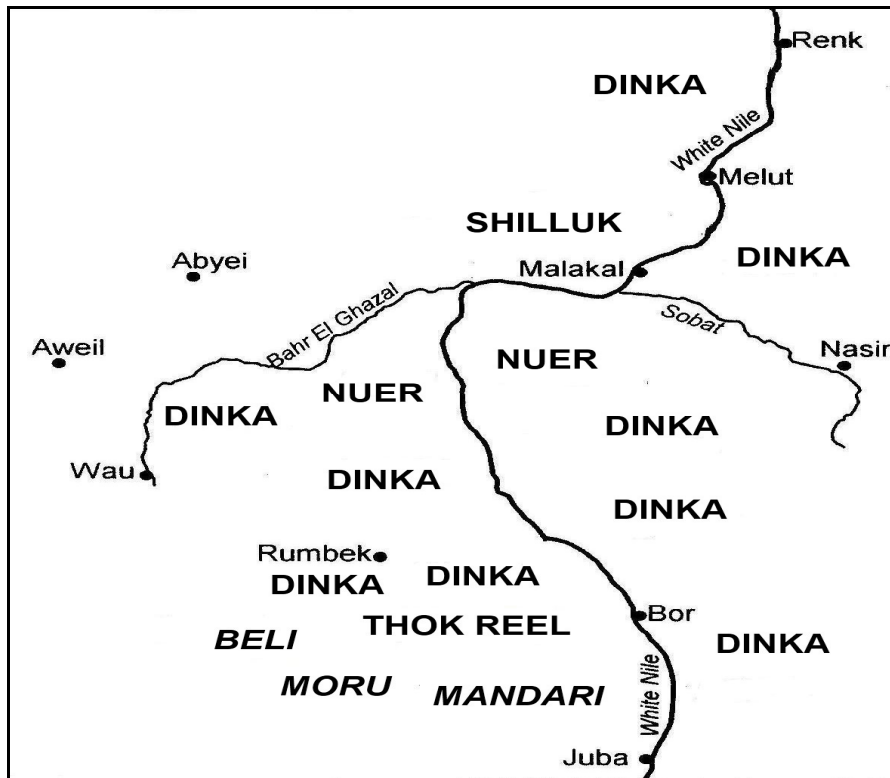


Figure 2. Thok Reel and neighbouring languages. Western Nilotic languages (bold), non-Western Nilotic (italics). Adapted from Dinka dialect map: [http://projects.beyondtext.ac.uk/dinkaspeech/uploads/dinkadialectmap.pdf]

Thok Reel is the only language within its subgroup for which, according to Storch (2005:23), there is virtually no linguistic information available. I have found a word-list in Roettger & Roettger (1989) and a series of anthropological publications by John W. Burton (1981a, 1981b, 1987) which contain some observations on the aspects of history of the language and sociolinguistics. By contrast, there is a fair amount of linguistic literature on both Dinka (Andersen 1987, 1990, 1993, 2002; Malou 1988; Remijsen & Gilley 2008; Ladd, Remijsen & Manyang 2009; Remijsen & Manyang 2009; Storch 2005, among others) and Nuer (Crazzolara 1933; Frank 1999; and Storch 2005, among others). Both Dinka and Nuer have orthographic systems.

1.3. Thok Reel and its speakers

The speakers of Thok Reel are known as Atuot (or Atwot). Their language is referred to in literature as Atuot or Reel. Here I will refer to the language by the name used by the speakers of the language – Thok Reel /tók r̄eel/ which literally means ‘the language of the Reel people’. The self-reference name for the speakers of Thok Reel is Reel /r̄eel/ (SG /r̄el/). Here, however, I will refer to the people as “Atuot” since this is the name by which the people are known outside of their immediate community and it is also the name that the people themselves are happy to be known by. This name is also used as a self-reference by a group that comprises of Reel and Apak people. The speakers of Thok Reel comprise five of the six sections of the Atuot – Jilek, Luac, Jikeyi, Kuek and Akot.² The sixth section, Apak, speaks Thong Apak which is a dialect of Dinka.

The speakers of Thok Reel distinguish two dialects: Thok Reel Cieng Luai and Thok Reel Cieng Nhyam. Thok Reel Cieng Luai (lit. ‘language of the homeland of the Luac Reel’) is spoken by Jilek, Luac and Akot. These three sections live along the north-eastern frontiers of the Atuotland, bordering Aliab, Ceic and Agar Dinka (see Figure 3). Thok Reel Cieng Nhyam (lit. ‘language of the homeland of the Reel of the front side’) is spoken by Kuek and Jikeyi. The two sections live around the Mapuordit area – along the south-western boundaries of the Atuotland. They border Mundari, Moru and Jur Bel (the speakers of Beli), see Figure 2 above.

² Jikeyi is a Reel name for the section that is more widely known as Rorkec. Rorkec is a Dinka name for the Jikeyi (“Rorkec” is also used in Burton 1981a, 1987).



Figure 3. Map of the Atuot and Dinka sections and dialects. Sections: Atuot (bold) and Dinka (italic). Dialects (underlined): Thok Reel Cieng Luai speaking sections (solid line); Thok Reel Cieng Nhyam speaking sections (dashed line); and Dinka dialects (dotted line).

The difference between the two dialects is reported to be purely lexical. There is a fair amount of lexical borrowing from Dinka by the speakers of Thok Reel Cieng Luai.

Thok Reel Cieng Nhyam, by contrast, has retained many of the Nuer lexical items that are no longer found in Thok Reel Cieng Luai. Table 1 gives an example of a Dinka-Nuer subgroup dialect continuum exemplified by a word ‘footpath’ given in two Dinka dialects, two Thok Reel dialects and Nuer. Observe that a cognate is used in Thok Reel Cieng Luai and the two Dinka dialects, and a different cognate is used in Thok Reel Cieng Nhyam and Nuer.

Table 1. Dinka-Nuer subgroup dialect continuum.

	Dinka (Thong Monywaang)	Dinka (Thong Apak)	Thok Reel Cieng Luai	Thok Reel Cieng Nhyam	Nuer
<i>footpath</i>	kwɛ̄ɛɛr	kwɛ̄ɛr	kwɛ̄ɛr	dwóɔp	dwóɔɔp

Around 80% of the Atuot are bilingual in Thok Reel and Dinka. The 20% of the monolinguals come from the older generation of the more conservative Kuek and Jikeyi sections. Many native speakers of Thok Reel are also fluent in Sudanese Arabic and English. When writing Thok Reel, the native speakers use Dinka spelling conventions.

2. DATA COLLECTION AND ANALYSIS

The analysis presented here is based on data collected during two field trips to Southern Sudan – August-September 2009 and January-February 2010. During the first data collection trip I was based in the capital of Southern Sudan – Juba, and during my second trip I was based in Rumbek – the capital of Lakes State which is about 75 miles west from the Atuot area.

2.1. Language consultants

During the first data collection trip in Juba I collected data through elicitation sessions with ten native speakers of Thok Reel (nine male, one female). The speakers came from three Atuot sections: Luac, Jilek and Kuek. The speakers were between 14 and 45 years of age. Some speakers were new arrivals to Juba from the Atuotland. Others spent most of their lives outside the native area. All speakers were fluent in Dinka, and had varying proficiency in English. Elicitation sessions were conducted in English. The first data collection trip served as an initial introduction to the sound system, morphology and syntax of Thok Reel. The data collected during this trip was used to postulate initial hypothesis about the sound system and morphophonology.

During the second data collection trip in Rumbek I worked with two other native speakers of Thok Reel. The speakers came from Luac and Jilek sections. Both were in their late 20s, and have worked as school teachers in the Atuot area before moving to Rumbek. Both use Thok Reel, Dinka, English and Sudanese Arabic in their daily life. Both speakers consulted me over a period of nearly two months. Most data presented

here comes from these two language consultants. The elicitation procedure reported here was used during the second data collection trip.

2.2. Elicitation procedure

Whilst in the field I relied on my ears when transcribing the elicited data. I also conducted weekly recording sessions during which I have recorded most of the data elicited during the week. The data was recorded using a solid-state recorder (Marantz PMD660) and a dynamic headset microphone (Shure SM10). The recording was done at 48kHz sample rate, 16 bit depth; inscription of the sound files was mono wav.

2.3. Materials used in analysis

The descriptive analysis presented here is based on 93 verb paradigms and 75 noun paradigms. Collected verbs were of two types – *transitive* (51 lexical stems) and *antipassive* (42 lexical stems). Both types of verbs are semantically transitive, or bi-valent (Payne 1997: chapter 8). Transitive verbs (TRANS, also left unmarked in glosses) take two obligatory arguments in a clause. Antipassive verbs (AP) are defined by Reh (1996: 385-390) as the verbal derivation which signals that the patient participant is either omitted from the clause or, is optional. The verb paradigms consisted of seven inflectional categories of finite verbs – verbs that take agreement with the subject (in Thok Reel a distinction is made between inclusive and exclusive 1PL). All verbs came from simple declarative sentences.

Noun paradigms consisted of 75 singular and plural stems. For the purposes of the current discussion, the singular and the plural nouns were counted as separate items. The noun paradigms consisted of four inflectional categories which I preliminary distinguish as four cases: nominative, accusative, genitive and locative. Nominative (NOM) is a case of citation form, of a subject in a simple declarative clause, and of a head noun in a noun phrase. Accusative (ACC) is the case used to indicate that the noun is an object in a simple declarative clause with transitive verbs. Genitive (GEN) is the case of a possessor in a possessive construction, and of an object in clauses with the antipassive verbs. Locative (LOC) is a case used to indicate location.

The nouns were elicited in various contexts. The contexts were chosen in order to study the tone system. Description of the contexts will be given in the section on tone (6.3.1).

2.4. Data analysis

This section gives a general introduction to the methodological approaches employed in working with the data.

The choice for the methodological approaches was motivated by the general difficulty that a native speaker of an Indo-European language, like myself, faces when working with some of the Western Nilotic languages. This difficulty is of a perceptual nature: not being able to perceive and to categorise between some of the segmental and suprasegmental distinctions. For example, Thok Reel has an unusually rich inventory of suprasegmental distinctions such as three-way vowel length distinction, two-way

voice quality distinction and three tonemes. Morphology to a large extent is expressed by alternations of these phonological parameters on the monosyllabic words. For a native speaker of a language that does not utilise these distinctions, working with Thok Reel entails learning a whole load of new categories, and being able to tease apart the various combinations of the distinctions within words. Even for a trained phonetician it is often difficult to discern the independent combinations of the phonological parameters by ear alone, rendering the process of transcription to be a particularly laborious task.

Therefore, special care was taken when analysing the data. Transcription of the data was done in several stages. During the sessions with the native speakers I relied on my ears to transcribe the data. I have also asked the speakers about their intuition in relation to some of the vowel categories that I found particularly difficult to tell apart (see section 5.3.3.3). Most of the data was recorded and my field transcriptions were subjected to further scrutiny with the help of the recorded data. I have carried out some basic instrumental measurements of the acoustic data (waveforms, spectrograms, fundamental frequency traces, etc.) in order to verify perceptual impressions.

Because much of the morphology is encoded by means of the phonological alternations, the best way to study phonology of the language is to work on the morphophonology. In working with the Thok Reel data I found it useful to concentrate on one issue at a time. For example, when working on vowel length alternations I would ignore tone and voice quality alternations. In this way, any required modifications to the field transcriptions were applied in stages which reflected my growing knowledge of the data. The stage of working with the

recordings, therefore, was particularly lengthy, but the benefit of it was that my perception of the categories that I found challenging during the initial stages of research, has sharpened in the process.

The acoustic data was processed and analysed using speech analysis software Praat (Boersma & Weenink 2005). One of the important steps in analysing the acoustic data is the segmentation criteria one adopts. Turk, Nakai, & Sugahara (2006) in their practical guide to acoustic segment durations in prosodic research, state that ‘Segmenting the speech signal into phone-sized units is somewhat of an artificial task, since the gestures used to produce successive speech sounds overlap to a great degree’ (Turk, Nakai, & Sugahara 2006:2). The authors, thus highlight the need for an application of consistent segmentation criteria. Consistency in segmentation was particularly relevant for the process of conducting an instrumental analysis on Thok Reel vowels. The segmentation criteria that I have adopted in the analysis of vowels will be discussed in section 5.3.2.

3. WORD STRUCTURE

The majority of words in Thok Reel are monosyllabic. These include morphologically simple and morphologically complex words. Morphologically complex words can also exceed one syllable. In this section I will give a description of the monosyllabic and polysyllabic words. Because the notions of syllable and word are often synonymous in Thok Reel, the description of the syllable structure will be preceded by a brief description of the morphophonological processes that modify the internal structure of the syllable 3.1. In section 3.2 I will give a description of the syllable structure. In section 3.3 I will deal with polysyllabic words and in section 3.4 with the structure of words that contain affixation.

3.1. Monosyllabic words

In Thok Reel words are largely monosyllabic. This is a common characteristic of many Western Nilotic languages (e.g. Andersen 1987, 1990, 1993 for Dinka; Gilley 1992, 2000 for Shilluk; Crazzolara 1933 for Nuer; and Storch 2005 on noun morphology of Western Nilotic languages). Monosyllabic words are usually associated with isolating languages such as Vietnamese. Thok Reel, however, is not an isolating language, on the contrary, it has complex morphology. A significant part of morphology is expressed by alternations in phonological material of the root. These alternations involve changes in vowel quality, voice quality, vowel length, stem-final consonant and tone. The following alternations are found in nouns and verbs: alternations in vowel quality (2a); alternations in tone (2b); alternations in vowel length (2c); alternations in voice quality (2d); and alternations in stem-final consonant

(2e). Most examples actually feature the combinations of the alternations: tone and vowel quality in the second pair in (2a); vowel length and tone in the second pair in (2c), tone and stem-final consonant in the first pair in (2e); and tone, vowel length and stem-final consonant in the second pair in (2e). The alternations in (2a, d) are used to distinguish singular and plural forms of nouns, and to express subject agreement in verbs. The alternations in (2b-c) are used to distinguish singular and plural forms in nouns and the derivational categories in verbs. The alternations in (2e) signal number and case marking in nouns.

(2)

a. vowel quality

j̣ɔ̣r	‘forest\SG\NOM’	~	j̣ạr	‘forest\PL\NOM’
ṭɛT	‘dig\3SG’	~	ṭɛ̄T	‘dig\1SG’

b. tone

ców	‘husband\SG\NOM’	~	còw	‘husband\PL\NOM’
nóooP	‘send\AP\3SG’	~	nòooP	‘send\3SG (word)’

c. vowel length

gàT	‘child\SG\NOM’	~	gàaaT	‘child\PL\NOM’
míṬ	‘feed\AP\3SG’	~	mìiiṬ	‘feed\3SG’

d. voice quality

ròooK	‘molar.tooth\SG\NOM’	~	ròooK	‘molar.tooth\PL\NOM’
nóooŋ	‘to.bring\AP\1SG’	~	nóooŋ	‘bring\AP\3SG’

e. stem-final consonant

jíC	‘belly\SG\NOM’	~	jíṬ	‘belly\PL\NOM’
ṛéec	‘rat\SG\NOM’	~	ṛéeej	‘rat\SG\GEN’

3.2. Syllable structure

Segmental templates for Thok Reel syllables are presented in (3). Most content words have closed syllables (3a). A typical syllable consists of a consonant at the onset that can be followed by one of the glides, a vowel that can be short (V), mid (VV) or long (VVV) and a coda consonant. Most function words and a small number of nouns have open syllables (3b). The syllable structures in (3) are exemplified in (4).

- (3) a. C (j/w) V (V) (V) C
 b. CV(V)

- (4) a. gàT ‘child\SG\NOM’
 cêŋ ‘sun\NOM’
 j̥ɔ̃r ‘forest\SG\NOM’
 réeC ‘rat\SG\NOM’
 t̥uuT ‘male.animal\SG\NOM’
 gàaaT ‘child\PL\NOM’
 jwíC ‘head\SG\NOM’
 cjêŋ ‘home\PL\NOM’
 gw̥P ‘skin\SG\NOM’
 rwâaj ‘conversation\SG\NOM’
 nwêer ‘human\SG\NOM’
- b. càa ‘PST\PASS’
 cĕ ‘PST\1SG’
 p̥i ‘water\NOM’³
 lá ‘animal\SG\GEN’
 cà ‘husband\SG\GEN’

³ Its Dinka cognate p̥iw ‘water’ is a closed syllable (data from Ladd, Remijsen and Manyang 2009)

3.3. Polysyllabic words

Whilst the majority of words are monosyllabic, there are also a small number of words with more than one syllable. These can be separated into three categories. First, there are native polysyllabic words (5a). The first syllable in such words can be a-, í-, è-, dàa-, and ma-. Second, there are native compound words (5b). Third, there are loan words (6).

- (5) a. aḍḍèer ‘water.pot\SG\NOM’
 íṅḡaw ‘so and so, such and such’
 èkèC ‘bitter’
 dàapóooK ‘decorated.pot\SG\NOM’
 makéC ‘yellow’
 madíT ‘MadiT’ (male name)
- b. kwaC-reng ‘Kwacreng’ (male name)
 pan-kḡar ‘Pankar’ (name of a village in Atuot territory)
 mapuor-diT ‘Mapuordit’ (name of a town in Atuot territory)
- (6) à máaná ‘meaning’ (from Arabic)
 gálám ‘pen’ (from Arabic)

3.4. Affixation

In addition to stem-internal alternations, morphology can be expressed by means of affixation. Example (7) shows that a verb can contain both a prefix and a suffix (7a), and a noun can contain a suffix (7b).

- (7) a. è-dɛ̀ɛw-ɛ̀
 DECL-distribute\AP-1SG
I am distributing.
- b. tɪ̀uuT-ɛ̀
 male.animal-PLANOM
male animals

Although the inflected stem in Thok Reel can have prefixes and suffixes, I restrict the term *stem (syllable)* to the root syllable, and, by extension, I will refer to the vowel that occurs in this syllable as *stem vowel*, to the initial consonant(s) and to the final consonant of the stem syllable as *stem initial consonant(s)* and *stem-final consonant*, respectively.

The template in (8) gives a schematic representation of the order of morphemes in finite verbs. All finite verbs that I have considered so far come from simple declarative clauses. The verb stem in such clauses is prefixed by a declarative particle è- (DECL). This particle combines with the 3PL subject agreement marker (SM). Subject agreement in most cases is expressed by means of suffixation. The 1SG suffix only occurs with antipassive verbs (8b); the 3PL suffix only occurs with transitive verbs (8a); and the 3SG form is unaffixed in both transitive and antipassive. Negation (NEG) is expressed by means of prefixation. The prefix attaches to the left edge of the verb stem (8c). Note that I treat both the declarative particle and the negation particle as prefixes. An alternative would be to treat them as separate words. For example, Andersen (1991, 1993) analyses the declarative particle as a prefix in Dinka, whilst in Nuer it is analysed as an independent particle (Crazzolara 1933 and Matthew Baerman p. c.). I am yet to confirm the status of both particles in Thok Reel.

(8) (3PL.SM) \ DECL – (NEG) – VERB STEM – SM

	a. ‘distribute’	b. ‘distribute\AP’
1SG	è-dáaw	è-dɛɛw-ɛ́
2SG	è-dɛɛw-í	è-dɛɛw-í
3SG	è-dɛɛw	è-dɛɛw
1PL.INCL	è-dáaw-kòn	è-dɛɛw-kòn
1PL.EXCL	è-dáaw-kò	è-dɛɛw-kò
2PL	è-dáaw-èj	è-dáaw-èj
3PL	kèɛ-dáaw-è	kèɛ-dɛɛw

c. NEG

è-tíł-ńjáaar	bûr
DECL-NEG-like\1SG	camp\SG\ACC
<i>I don't like the camp.</i>	

The suffix -nɛ́ is used with some nouns (noun classes) to signal inflection for plural (9a) and case: genitive in (9b) and locative in (9c). This suffix has two allomorphs -nɛ́ and -ɛ́. The former attaches to stems that end in a vowel or a glide (cf. nêej ‘person\PL’). The allomorph -ɛ́ attaches to the stems that end in a consonant.

(9) a.	tùuuT-ɛ́	‘male.animal-PL\NOM’
	dàapóoK-ɛ́	‘decorated.pot-PL\NOM’
b.	nèee-nɛ́	‘person\PL-GEN’
	píi-nɛ́	‘water-GEN’
c.	jéeer-ɛ́	‘water.area\PL-LOC’
	bwór-ɛ́	‘camp\PL-LOC’

With adjectives that are used as modifiers in noun phrases, partial reduplication is used to signal intensification. The reduplicative morpheme (RED) attaches as a prefix

to the left edge of an adjective (10). I have not yet investigated reduplication in adjectives in detail. The description given here reflects the reduplication in adjectives that will be presented in this document. In all examples in (10) the reduplicative construction consists of a consonantal slot unspecified for place and manner of articulation and a default vowel /e/ (11). The first consonant of an adjective reduplicates into the consonantal slot in the template.

- (10) lé-lâaaŋ
 RED-good\PL\ATTR
- lé-lêŋ
 RED-good\SG\ATTR
- bé-bêr
 RED-tall\SG\ATTR
- ʔé-ʔâaj
 RED-big\PL\ATTR

(11) Reduplication template (preliminary version)

Ce- RED

4. CONSONANTS

In this section I will give a descriptive account of phonetics and phonology of Thok Reel consonants and present a brief description of some of the morphophonological alternations. Section 4.1 will account for the inventory, section 4.2 deals with phonetics and phonology and section 4.3 deals with phonotactics. In section 4.4 I will give a description of the two most frequently occurring morphophonological alternations.

4.1. Inventory

There are twenty consonant phonemes in Thok Reel. They are listed in Table 2 and illustrated in (12) where they occur in the onset position of syllables with low vowels. For phonological reasons plosives are distinguished in terms of the feature [+/- voice] (see section 4.3). Voiceless [-voice] plosives come in six places of articulation. Voiced [+voice] plosives and nasals come in five places of articulation. There are no fricative phonemes. There is a vibrant, a lateral and two glides. The two glides are the palatal /j/ and a (labio)velar /w/. For morphophonological reasons /w/ is placed into the velar column of the Table 2 (see section 4.4).

Table 2. Consonant phonemes.

		labial	dental	alveolar	palatal	velar	glottal
plosive	- voice	p	t̪	t	c	k	ʔ
	+ voice	b	d̪	d	j	g	
nasal		m	ɲ	n	ɲ	ŋ	
lateral				l			
vibrant				r			
glide					j	w	

(12)

páaaP ‘spread\1SG’	bâaar ‘boldness’	máC ‘fire\SG\NOM’
táaal ‘cook\1SG’	d̪âl ‘boy\PL\NOM’	ɲjáaar ‘like\1SG’
táaaT̪ ‘build\1SG’	d̪áaw ‘distribute\1SG’	n̪áaw ‘kill\1SG’
cáam ‘eat\1SG’	j̪áT̪ ‘tree\SG\NOM’	ɲál ‘girl\SG\NOM’
k̪âaar ‘dry\1SG’	gàaaT̪ ‘child\PL\NOM’	ɲâaw ‘vomit\1SG’
ʔáaal ‘pound\1SG’		
láaaK ‘insult\1SG’	ràaK ‘lulu.tree\SG\NOM’	
wáaar ‘change\1SG’	j̪âɲ ‘cow\SG\NOM’	

4.2. Phonetics and phonology

With a few exceptions, the realisation of the phonemes is reflected by their IPA transcription. The lateral is always palatalised, so that /rêel/ ‘Reel people’ and /lwàc/ ‘Luac’ are pronounced as [rêeel^j] and [l^jwàc], respectively. Labial, dental and palatal stops can be realised as fricatives, so that /âpák/ ‘Apak’, /tók/ ‘mouth\SG\NOM’ and /çèk/ ‘woman\SG\NOM’ are often pronounced as [âpák], [sók], and [çèk], respectively. In slow deliberate speech dental stops are sometimes produced as interdental.

4.2.1. *The glottal phoneme*

The sound that I analyse as a glottal stop is informally written by the native speakers of Thok Reel as <ɣ> after the orthographic representation of a similar sound in Dinka. Researchers working on Dinka vary in their analyses of the sound represented as <ɣ> in the orthography of the language. Duerksen (1989) analyses it as a phonetic feature of syllables that begin with vowels, and Andersen (1993) and Remijsen & Manyang (2009) analyse it as a velar approximant. It is evident that the definition of the sound represented as <ɣ> in Dinka is a point of controversy. Therefore, I will present some acoustic data to support my interpretation of this sound in Thok Reel as a glottal phoneme.

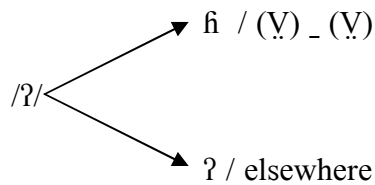
The problem with determining the manner of articulation of this sound is that its production cannot be readily observed. Relying on acoustic data in studying this sound is useful, as it provides an account of acoustic properties of a sound which can tell us, amongst other things, about its place and manner of articulation. In what

follows I will discuss the acoustic properties and the allophonic distribution of the glottal phoneme in detail.

The phoneme /ʔ/ has two allophones: [ʔ] and [h]. [h] occurs in the context of breathy vowels (13a) and [ʔ] elsewhere (13b). These observations are captured in (14).

- (13) a. ʔḥT [hḥt] ‘house\SG\NOM’
 ʔḥaal [hḥaal] ‘pound\1SG’
- b. ʔḥT [ʔḥt] ‘head\PL\NOM’

(14)



The acoustic correlates of the perceived glottalisation for [ʔ] correspond to what Redi and Shattuck-Hufnagel (2001:414) describe as *glottal squeak*. Glottal squeak is characterised by a sudden increase in f0 which is sustained at a low amplitude for multiple periods. This point is illustrated in Figure 4 where we can observe a low amplitude increase in fundamental for multiple periods before the onset of the vowel (periodic waveform).

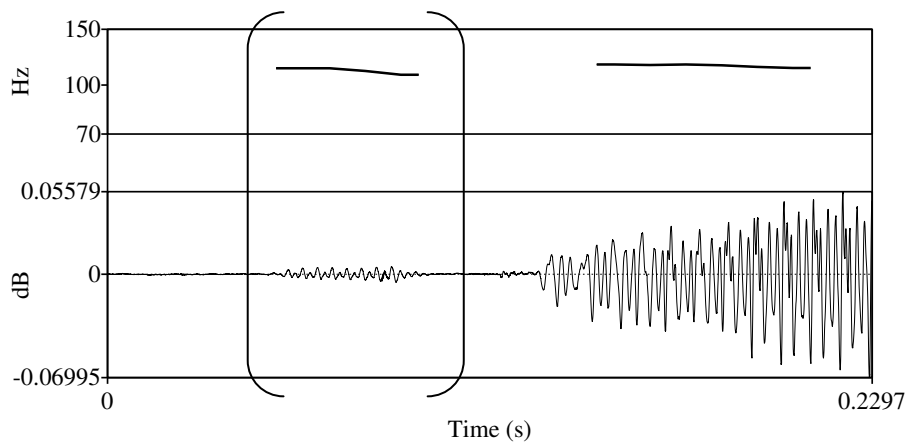


Figure 4. Acoustic representation of the glottal sound at the onset of the word $\text{?}\zeta\text{T}$ 'head\PL\NOM'. Top panel: fundamental frequency traces; bottom panel: waveform. Brackets delimit the portion of the glottal squeak.

The allophone [h] sounds like a breathy voiced approximant. The perceived breathiness is not surprising considering that the distribution of this allophone is conditioned by the adjacency to breathy vowels. The perception of this sound as approximant is confirmed by the acoustic representation in Figure 5.

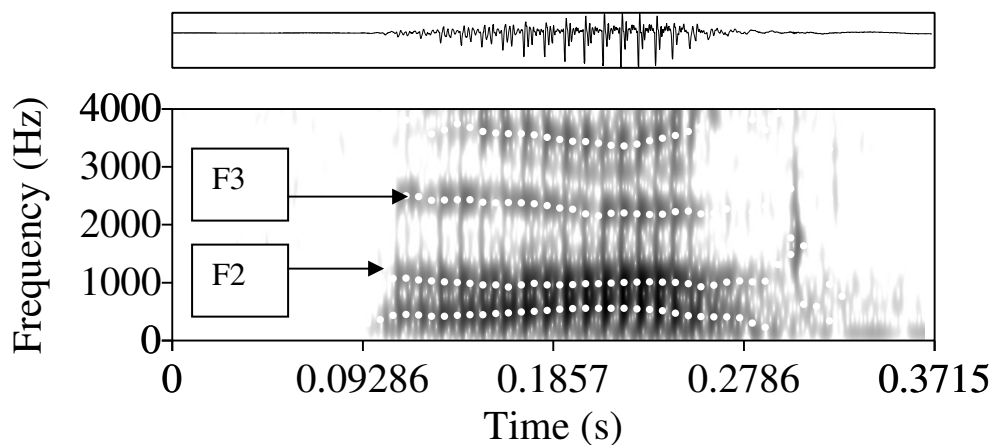
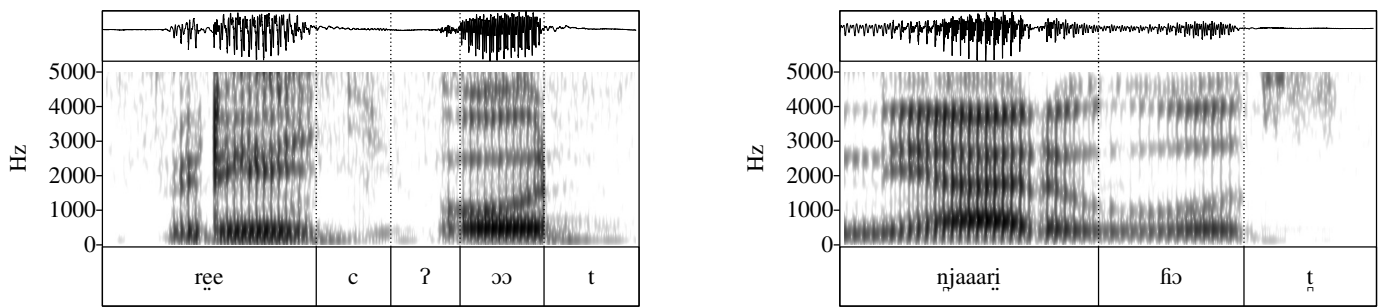


Figure 5. Acoustic representation of the glottal sound at the onset of the word $\text{?}\zeta\text{K}$ 'cow\SG\NOM'.

We can see that in Figure 5 there are clearly defined formants (as shown by white dot traces) from the onset of voicing. However, the energy (shading) above F2 is low at the onset of voicing as compared to the offset of voicing. The presence of the formant structure and the low energy is characteristic of approximants. In Dinka, this sound was described as a velar approximant (Andersen 1993; Remijsen & Manyang 2009). In Thok Reel, however, this sound is not a velar. With velar sounds we would expect the occurrence of the so-called *velar pinch* – rise in F2 and lowering of F3 resulting in close proximity of these formants. Figure 5 shows that F2 and F3 do not come close to one another. Bert Remijsen (p.c.) notes that this consonant could be an approximant that is produced either at the glottis or at the pharynx. Ladefoged points out that cross-linguistically [h] cannot be said to be a fricative, but is ‘best regarded as a state of the glottis without a specific place’ (Ladefoged 2006:256). Ladefoged & Maddieson (1996:325-6) comment that during the production of [h] the shape of the vocal tract is that of the surrounding sounds. This means that during the production of this sound the glottis is less constrained than is required for the production of a fricative. Hence, this sound is best described as approximant. The descriptions of [h] reflect the acoustic representation of the glottal sound in Figure 5.

In connected speech, the nature of the preceding context also conditions the realisation of the glottal phoneme. Figure 6 shows that when the glottal sound is preceded by a consonant (panel A), it is realised as [ʔ] when the following vowel is modal. When preceded by a breathy vowel (panel B), it is realised as an approximant even if the following vowel is modal. Compare the realisation of the glottal sound in panel B with that in panel C where the word ʔóŋ occurs in isolation. Following the pause, the consonant at the onset in panel C is realised as a voiceless stop.

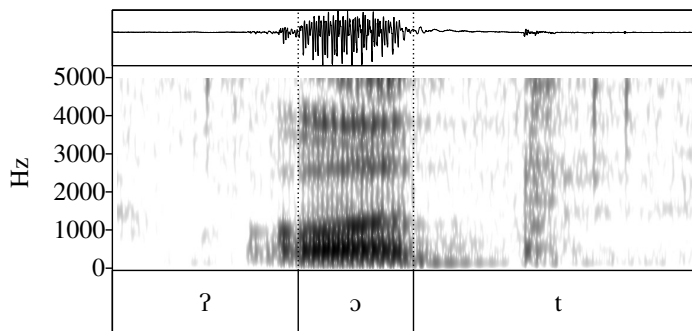


Panel A.

r̥eɛ ʔɔɔ̄T
 rat\SG\NOM house\SG\GEN
The house rat.

Panel B.

è-nj́aaar-í ʔɔ̄T
 DECL-like-2SG head\PL\ACC
You like the heads.



Panel C.

ʔɔ̄T ‘head\PL\NOM’

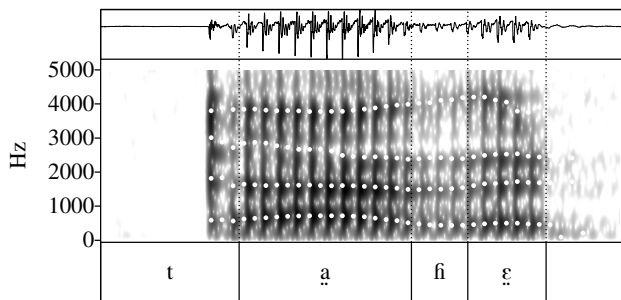
Figure 6. Acoustic representations of the glottal phoneme followed by a modal vowel in various contexts. In panel A the target syllable is preceded by a consonant; in panel B it is preceded by a breathy vowel; and in panel C it occurs in phrase-initial context.

In addition, in non-emphatic realisations of the word ʔɛ̄n ‘I’ and its reduced form ʔɛ̄, this sound can be realised as nothing at all in phrase-initial position (15a) and as a palatal glide following a high vowel /i/ (15b). The processes responsible for the realisations in (15) can be described as deletion (15a) and palatalisation (15b). Both processes can be classified as progressive assimilation: in (15a) to preceding Ø [zero] and in (15b) to the preceding high vowel. The behaviour of this sound at the onset of

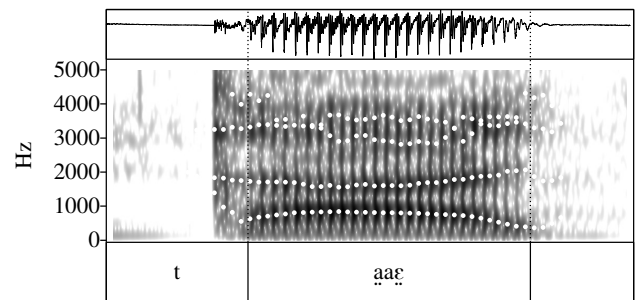
ʔén and ʔé in other contexts remains to be investigated, therefore, I will postpone postulating the rules to account for the examples in (15) until more evidence has been collected.

- (15) a. ʔén [hén] / [én] ‘I’
- b. [péeenì jè]
- è-péeen-í ʔé
- DECL-prevent-2SG 1SG
- You are preventing me (from doing something).*

When ʔé is preceded by a breathy vowel, the realisation of the glottal sound can also vary. Figure 7 shows that it can be realised as a [h] (panel A), or as nothing at all (panel B). Observe that in the middle of the vocalic portion in panel A there is less energy between the formants on the spectrogram (middle tier), and a decrease in the amplitude on the waveform display (top tier). The formants in panel A are in transition from one vowel to the next. In panel B, the energy remains constant for the whole periodic portion as is evident from the spectrogram and the waveform displays. There is a formant shift at the offset of the vocalic portion in panel B. This suggests that there are two juxtaposed vowel segments in the word but no intervening consonant segment, which means that the word is pronounced as [tʌaɛ]. I however, tend to perceive the rendition in panel B as [tʌaa] (see 5.3.3.3). The acoustic representation in panel B tells us that there is a complete assimilation of the glottal sound to the preceding vowel (since this sound appears to exhibit a progressive assimilation elsewhere).



Panel A.



Panel B.

Figure 7. Acoustic representations of the glottal phoneme between breathy vowels in $t\acute{a}ʔ\acute{\epsilon}$ 'I have'. Panel A – less energy between the formants during the portion of the intervocalic consonant. Panel B – the energy level is constant throughout the vocalic portion.

No assimilation takes place when this sound occurs in other words (16).

- (16) [è-cḙ fḙk]
 è-cḙ ʔḙK nḙjâaar
 DECL-PST\1SG cow\PL\ACC like\TRANS
I have liked the cows.

- [è-fḙd-ḙ]
 è-ʔḙT-ḙ
 DECL-pound\AP-1SG
I am pounding.

The last point that we should consider in the discussion on the glottal sound is a possibility that this sound is a phonetic feature of the syllables that begin with vowels. This analysis was proposed by Duerksen (1989) for the Dinka sound represented as <γ> in the orthography. Example (17) shows that there are words in Thok Reel that begin with vowels and no perceived glottalisation occurs at the beginning of such words. Thus, the perceived glottalisation at the onset of words like that in (16) cannot

be attributed to the phonetic feature of the syllables that begin with vowels. The same argument was given for the Luanyjang dialect of Dinka (Remijsen & Manyang 2009).

- (17) ad̥ɛ̃ɛɛr ‘water.pot\SG\NOM’
 ɪŋâaw ‘so and so, such and such’
 èkèC ‘bitter’

In summary to this section, the glottal phoneme /ʔ/ has two allophones [ʔ] and [ɦ]. [ɦ] occurs in context of breathy vowels and [ʔ] elsewhere. I have presented acoustic evidence in support of my analysis of the sound as a glottal sound. Using the descriptive categories proposed by Redi & Shattuck-Hufnagel (2001) I have described the acoustic realisation of the stop allophone [ʔ] as a glottal squeak. The allophone [ɦ] exhibits the acoustic properties of an approximant. The formant trajectories observed during the production of this sound as well as its tendency to assimilate to the neighbouring sounds is compatible with Ladefoged & Maddieson’s (1996) description of [ɦ]. I have shown that this sound tends to assimilate to the preceding context when it occurs in the word ʔɛ̃n ‘I’.

4.2.2. *Sonority*

I classify the consonantal sounds in terms of the feature specification [+/- sonorant]. This feature specification distinguishes between the sounds that are produced with constrictions which either permit or inhibit spontaneous voicing and, hence pitch production. This distinction will be useful in the description of the phonetics of tone. The [-sonorant] consonants are produced with a constriction that inhibits spontaneous voicing. These are voiced and voiceless stops. With the glottal consonant, only the

allophone [ʔ] is counted as [-sonorant] since we saw that the allophone [h̥] is an approximant. The rest of the consonantal sounds: the glides, [h̥], /l/, /r/ and the nasals are considered to be [+sonorant].

4.3. Phonotactics

All but one consonants occur in simple onsets. So far I have not come upon an example of a dental nasal in a simple onset. This consonant occurs in complex onsets followed by a palatal glide (see (12) above). With the exception of the glottal consonant and /w/, all consonants can occur in complex onsets, and in particular, stem-initially, where they are followed by one of the two glides. I have only come across one word that contains a glide-glide sequence at the onset (18). In fluent speech the sequence /jw/ is coarticulated and is realised as [ɥ]. Andersen (1993:4-5) also comments that in Dinka a glide-glide sequence in syllable's onset (albeit the inverse /wj/) is realised as [ɥ].

(18) jwɨ́C ‘head\SG\NOM’

Voicing is only distinctive in the onset position (19), and more specifically, with stem-initial consonants (19b).

(19)	a.	páaaP	‘spread\1SG’
		bâaar	‘boldness’
	b.	apáal [apáal]	‘knife\SG\NOM’
		abáar [abáar]	‘running’

Except for the glottal phoneme, all consonants occur in stem-final (coda) position. In this position voicing is not distinctive for plosives. They are realised as voiceless when they occur phrase-finally and before a consonant (20a). In intervocalic position they are realised as voiced (20b). Similarly, in connected speech, terminal plosives followed by a vowel are often voiced (21).

(20)	a.	b.
	[è-kéεp]	[è-kéεb-ì]
	è-kéεP	è-kéεP-í
	DECL-hold\AP\3SG	DECL-hold\AP-2SG
	<i>He is holding.</i>	<i>You are holding.</i>
	[è-mít]	[è-míd-ì]
	è-míT	è-míT-í
	DECL-feed\AP\3SG	DECL-feed\AP-2SG
	<i>He is eating.</i>	<i>You are eating.</i>
	[è-hót]	[è-hód-ì]
	è-ḡT	è-ḡT-í
	DECL-pound\AP\3SG	DECL-pound\AP-2SG
	<i>He is pounding.</i>	<i>You are pounding.</i>
	[è-ηέεC]	[è-ηέεɟ-ì]
	è-ηέεC	è-ηέεC-í
	DECL-milk\AP\3SG	DECL-milk\AP-2SG
	<i>He is milking.</i>	<i>You are milking.</i>
	[è-lέεK]	[è-lέεg-ì]
	è-lέεK	è-lέεK-í
	DECL-insult\AP\3SG	DECL-insult\AP-2SG
	<i>He is insulting.</i>	<i>You are insulting.</i>

- (21) [è-nóob ad̪ɛɛr]
 è-nóobP ad̪ɛɛr
 DECL-send\1SG water.pot\SG\ACC
I am sending the water pot.

In the phonemic transcription employed in this document I use the morphophonemes {P, ɽ, T, C, K} to represent the stem-final consonants. The brackets {P} represent the structural level (which is left unmarked in examples). The rule in (22) tells us that the stem-final consonant is voiced intervocally, otherwise it is realised as voiceless.

- (22) {P, ɽ, T, C, K} $\begin{cases} \rightarrow [+ \text{voice}] / V _ V \\ \rightarrow [- \text{voice}] / \text{elsewhere} \end{cases}$
 stem-final C

4.3.1. Glides in onset and coda positions

Syllables like that in (23) could in principle be analysed either consisting of glide-vowel (23a), vowel-glide (23b) and glide-vowel-glide (23c) sequences or as diphthongs (23a-b) and triphthongs (23c). I treat these sequences as glide-vowel-glide for phonological and phonotactic reasons outlined below.

- (23) a. c̪ɛ̃ɛɛŋ ‘home\SG\NOM’ kwôɔɔT ‘blow\1SG’
 ɲjáam ‘put.into.mouth\1SG’ gwɔ̃P ‘skin\SG\NOM’
 b. r̪éɛɛj ‘rat\PL\NOM’ ŋâaw ‘vomit\1SG’
 c. rwâaj ‘conversation\SG\NOM’ lwóɔj ‘work\1SG’

In Moraic theory (Hayes 1989), the length of a given segment is represented by the number of morae. If we are to treat sequences like that in *cjɛ̃ɛɛŋ* ‘home\SG\NOM’ as diphthongal then, phonologically speaking, we will assign the timing units (mora) to all components of a diphthong. The total mora count for our example, therefore, will be four morae. However, there is no evidence to support the existence of four-moraic syllables in Thok Reel as there are no syllables that contain four-moraic monophthongs. Treating the glide as part of the diphthong in *cjɛ̃ɛɛŋ*, therefore is problematic for phonological reasons.

Another argument against interpreting the vocalic sequences as diphthongal and triphthongal comes from the observation that the sequences in (23a) are always closed by a consonantal coda. If we were dealing with diphthongs and triphthongs in examples like (23b-c), then we would have expected that these sequences would at least in some cases be closed by a coda consonant. This however, never happens. Thus, phonotactically, the second element in the vocalic sequences in (23b) and the third element in (23c) are consonants. The same argument was given in Remijsen & Manyang (2009) for Dinka.

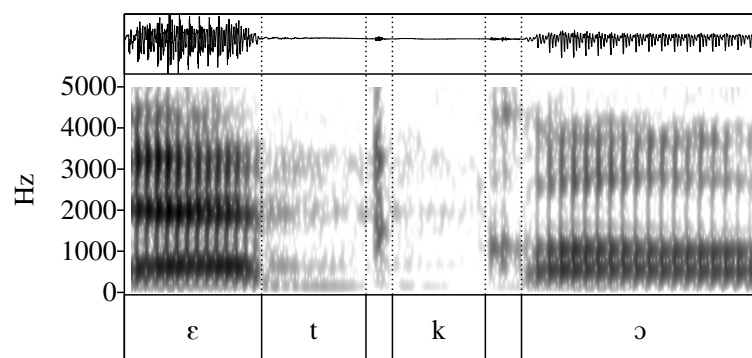
4.3.2. Consonantal clusters

In Thok Reel words, consonantal clusters can occur at morphological boundaries. So far I have mainly investigated the clusters that arise with the addition of inflectional suffixes. For example, agreement suffix for the first plural subject (1PL.EXCL) begins with a voiceless velar stop *-k̥* (24).

(24) DECL-verb.stem-1PL.EXCL

è-kḗP-kò	<i>We (excl.) are holding (AP).</i>
è-rwḡm-kò	<i>We (excl.) are finishing (AP).</i>
è-kwḡT-kò	<i>We (excl.) are blowing on (something).</i>
è-rḡḡḡ-kò	<i>We (excl.) are reaching (AP/PET).</i>
è-bíT-kò	<i>We (excl.) are being quiet (AP).</i>
è-pḡḡḡ-kò	<i>We (excl.) are preventing (AP).</i>
è-dwḡC-kò	<i>We (excl.) are caning (AP).</i>
è-cwḡḡ-kò	<i>We (excl.) are burning (AP).</i>
è-ḡK-kò	<i>We (excl.) are informing (somebody).</i>
è-nóoḡ-kò	<i>We (excl.) are bringing (AP).</i>
è-wḡḡḡ-kò	<i>We (excl.) are changing (AP).</i>
è-dwól-kò	<i>We (excl.) are twisting (something).</i>
è-lwḡoj-kò	<i>We (excl.) are working (AP).</i>
è-nḡw-kò	<i>We (excl.) are killing (AP).</i>

The stem-final plosives in such cases remain voiceless and both components of a cluster are released. This can be observed in Figure 8 where we can see two closures marked by consonantal symbols on the annotation tier, and two closure releases (bursts) demarked by the vertical lines following the closure phases. The durations of the closure-release phases for the two consonants in Figure 8 are 85ms and 86ms, respectively. In addition, /t/ can have a fricative realisation in this context.



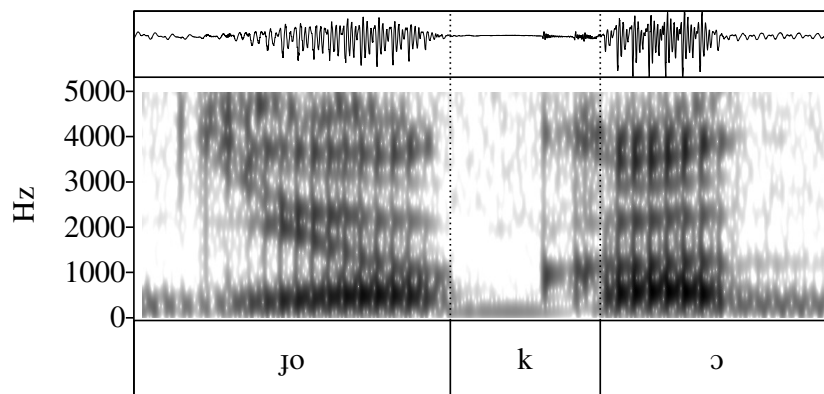
[tɛtkɔ]
 è-tɛT-kɔ
 DECL-dig-1PL.INCL
We (incl.) are digging (something).

Figure 8. Consonantal cluster at a morphological boundary. Durations for closure (consonantal symbols on the annotation tier) and release (demarked by vertical lines following the closures) phases are 85ms and 86ms, respectively.

In clusters where the oral stops have the same place of articulation (25), only one consonantal release takes place, just before the onset of the vowel. The consonant can be realised as a geminate, but in most cases it is produced as a singleton.

(25) [lókɔ] / [lókɔkɔ]
 è-lóK-kɔ
 DECL-hate-1PL.EXCL
We (excl.) are hating (somebody).

Figure 9 shows the realisation of a consonantal cluster in fluent speech. Two velar stops cluster at a morphological boundary, yet the closure-release phase is 81ms (cf. Figure 8). The singleton realisations of the clusters are never voiced, but remain voiceless.



[jókò]

è-jók-kò

DECL-inform-1PL.INCL

We (incl.) are informing (somebody).

Figure 9. Singleton realisation of two velar stops at a morphological boundary. The duration of the closure-release phase (demarcated by vertical lines) is 81ms.

The situation may be different with the consonantal clusters in compound words. So far, I have not investigated these words in detail. A small sample of compounds elicited from a number of speakers shows that some speakers insert an epenthetic schwa to break up the consonantal clusters. One example of epenthesis is found in the compound <Pankar> [panəkkaar] – the name of a village in the Atuot territory, which is composed of <pan> ‘land’ and <kar> ‘a kind of tree’. In connected speech, consonantal clusters arise through juxtaposition of words. In such cases some speakers also tend to insert an epenthetic vowel. As pointed out by Bert Remijsen in the latter cases what I think of as epenthesis could, in fact, be a morpheme (e.g. /e/). This issue remains to be investigated.

4.4. Morphophonological alternations in stem-final consonants

Alternations in stem-final consonants are used by morphology to signal inflection and derivation. In this section I will give a brief description of the two most frequently occurring alternations in Thok Reel C ~ j and K ~ w.

The stem-final stops C and K tend to occur in morphologically simple forms, and the glides /j/ and /w/ in morphologically complex forms. This point is exemplified in (26a) for the antipassive verbs which are derived from the corresponding transitive forms; in (26b) for singular and plural subject agreement in transitive verbs (see a description of basic vs. derived forms in person-number paradigms for verbs in section 5.4); and in (26c) for nouns. Note that in Thok Reel the form marked for number in a given singular-plural pair can be singular, plural or both; and the unmarked or morphologically opaque form, if present, can be either singular or plural. This ‘tripartite’ number marking system is a common feature of Nilo-Saharan languages (Dimmendaal 2000:214).

The alternations do not take place across the board as we also find examples where the stem-final C, K, j and w do not alternate (27).

(26)	a.	transitive verb stems	antipassive verb stems	
		kâC	kɛ̃ɛɛj	‘bite’
		lók	lòw	‘hate’
	b.	transitive plural stems	transitive singular stems	
		ɲâK	ɲâaw	‘vomit’
		kâC	kâaj	‘bite’
		lók	lóow	‘hate’
	c.	morphologically simple	morphologically complex	
		SG	PL	
		máC	mɛ̃ɛj	‘fire’
		rwôK	rôow	‘kidney’
		PL	SG	
		rwâC	rwâaj	‘conversation’
		SG	SG\GEN	
		cɛ̃K	cêew	‘woman’
		PL	PL\GEN	
		réC	réeej	‘fish’
(27)		SG	PL	
		lɛ̃j	lɛ̃ɛj	‘animal’
		ców	còw	‘husband’
		SG	SG\GEN	
		ʃíC	ʃèC	‘belly’
		ʃwíC	ʃwɛ́C	‘head’
		PL	PL\LOC	
		nêej	nêej	‘people’

5. VOWELS

5.1. Introduction

The purpose of this section is twofold: to give a description of the phonological distinctions and their phonetic realisations; and to give a descriptive account of the morphophonological alternations in vowel quality, voice quality and vowel length involved in inflection marking in verbs. Section 5.2 will account for the vowel inventory. Section 5.3 will present an acoustic analysis and section 5.4 will deal with the morphophonological alternations.

5.2. Inventory

5.2.1. *Vowel quality*

Thok Reel has seven vowel phonemes /i, e, ε, a, ɔ, o, u/. The near-minimal set in (28) shows the opposition for the four levels of vowel height for front and back vowels.

The phonemes combine with the suprasegmental distinctions – voice quality and vowel length.

(28)	bîiir	‘spear\3SG’	gûuur	‘father\2SG\NOM’
	bêeer	‘willow.for.roofing\PL\NOM’	góoor	‘search\3SG’
	béëer	‘tallness (length)’	gḍḍoor	‘mark\3SG’
	bâaar	‘boldness’	gáaar	‘body.mark\SG\NOM’

5.2.2. Voice quality

All vowels appear in two voice qualities – modal and breathy. The near-minimal set in (29) gives examples for each vowel phoneme. Breathily voice is represented in transcription by a diacritic mark placed under the first vowel symbol /Ṳ, ṲV, ṲVV/. The minimal pairs for voice quality are given for the seven vowel phonemes, however, the postulated voice quality distinction for the phoneme /u/ is tentative and will be discussed in section 5.3.3.2. The minimal set in (29) shows that voice quality is used to distinguish lexical items (examples /i/ ~ /Ṳi/, /e/ ~ /Ṳe/, /a/ ~ /Ṳa/, /ɔ/ ~ /Ṳɔ/, and /u/ ~ /Ṳu/) and to signal morphological distinctions (case /e/ ~ /Ṳe/, and number marking /o/ ~ /Ṳo/).

(29)	i	bîiir	‘spear\3SG’	bṲiir	‘drum\3SG’
	e	rêeel	‘Reel\PL\NOM’	rṲeel	‘Reel\PL\GEN’
	ɛ	wêêeer	‘scattering’	wṲêêeer	‘night\SG\NOM’
	a	cáaar	‘to.aim’	cṲáaar	‘black’
	ɔ	kḍḍor	‘forearm\SG\NOM’	kṲḍḍor	‘dry\3SG’
	o	ròooK	‘molar\SG\NOM’	rṲòooK	‘molar\PL\NOM’
	u	gúuur	‘remove\3SG’	gṲúuur	‘follow\AP\3SG’

The modal voice quality with some speakers is perceived as creaky voice. With most speakers it is easy to tell the difference between modal and breathily voice.

5.2.3. Vowel length

In Thok Reel vowels can be short /V/, mid /VV/, or long /VVV/. Vowel length is represented in transcription with single, double and triple symbols, respectively. Near-minimal sets are presented in (30). Vowel length is used to distinguish lexical items (e.g. /i̇, ii/ ~ /iii/, /e/ ~ /ee, eee/, /a/ ~ /aa, aaa/, etc.) and to signal morphological distinctions (e.g. number marking /i̇/ ~ /ii/, case /u̇/ ~ /uuu/, and derivational morphology /ε̇ε/ ~ /ε̇εε/).

(30)

i	ríŋ 'meat\PL\NOM'	rîŋ 'meat\SG\NOM'	rîiŋ 'run\PET\3SG'
e	rêl 'white.ant\SG\NOM'	rêel 'Reel\SG\NOM'	rêeel 'Reel\PL\NOM'
ε	téT 'dig\1SG'	têεT 'build.with.mud\AP\3SG'	têεεT 'build.with.mud\3SG'
a	ŋàC 'know\AP'	ŋáaC 'milking\1SG'	ŋàaaC 'milking\AP'
o	gwôr 'adjacent.siblings\NOM'	gwôor 'follow\3PL'	gwôoor 'elephant\SG'
o	kwôT 'rain\SG\NOM'	kwóoT 'blow\AP'	kwôooT 'blow\3SG'
u	bûl 'drum\SG'	bûul 'roast\AP\3SG'	bûuul 'drum\SG\LOC'

The duration of the short, mid and long vowels varies to some extent as a function of vowel height, the nature of the syllable, and presence of an utterance boundary. In phrase-medial position the long vowels tend to shorten more than the mid and the short vowels. This is especially true for one of the speakers whose vowels have been measured in this study.

5.3. Acoustic analysis

5.3.1. Materials used in analysis

The data set used in the acoustic analysis consisted of the words given in (28-30) as well as other words with various consonants in the onset and coda positions. The inclusion of the data from a variety of segmental contexts was motivated by studies (most notably Öhman 1965) which show that consonants with different places of articulation exert a small influence on the formant frequencies of adjacent vowels. The data came from a range of prosodic contexts. These consisted of phrase-initial, phrase-medial, phrase-final and citation form contexts.

The data was recorded over a period of time with two speakers. For each word I had around 3-5 recorded repetitions. Some recorded repetitions were rejected due to poor quality (e.g. background noise, disfluency, difficulties in locating formants for some of the breathy vowels, etc.). Whenever possible, all repetitions were analysed. For each word I have analysed between 1-5 tokens (i.e. vowels). The total tokens measured was 552. These tokens were used for the analysis of vowel and voice quality. For the analysis of vowel durations I excluded the syllables where the vowels

could not be reliably segmented from the adjacent segments (see section 5.3.2.1). The total tokens measured for the analysis of vowel durations was 412.

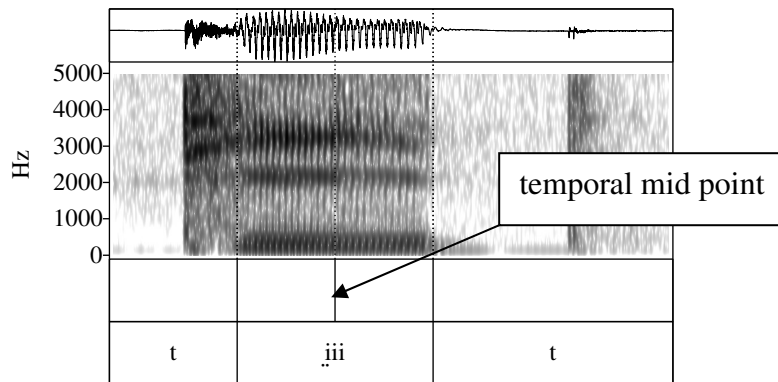
5.3.2. Data analysis

5.3.2.1. Formant measurements

The data was annotated in Praat (Boersma & Weenink 2005). The acoustic data was segmented by hand. In segmenting the acoustic data I have followed the guidelines for segmentation outlined in Turk, Nakai & Sugahara (2006). The authors distinguish between segments on the basis of relative segmentability. Some of the segments, such as oral stops, are reliably segmentable in most contexts in which they occur. Other segments, such as nasal stops, are reliably segmentable in some contexts and less reliably segmentable in other contexts. Yet, there are other segments which the authors label as ‘to be avoided’ (Turk, Nakai & Sugahara 2006:5). Amongst the latter type are the glides, the lateral and the glottal fricative. The authors point out that the onset and offset of these segments are difficult to identify. Glides are the non-syllabic versions of vowels (Ladefoged 2006:228), and just like the vowels, they have clearly defined formant structure. For example, the formant structure for [j] is that, or very close to, the formants structure for [i] and the formant structure for [w] is that, or very close to, the formant structure for [u]. This means that when we have a glide-vowel or vowel-glide sequence, the formants will be in transition from one segment to the next. When measuring these kinds of sequences it is not clear which point should be taken as the end of one segment and the beginning of another segment.

In what follows I will first describe the methods used in segmentation and formant measurements procedures in syllables where vowels occur between stop consonants, and I will then give a description of the strategies used to determine the points at which to measure the formants for the vowel in glide-vowel and vowel-glide sequences.

With vowels that occur between oral stops, for example, in words such as *t̪iit* ‘magic performance’ (Figure 10), the beginning of the vowel was demarked on the annotation tier at the onset of voicing. The end of the vowel portion was demarked at the point of the decrease in the overall amplitude and cessation of formants (Turk, Nakai & Sugahara 2006). The formant settings were adjusted for each speaker individually. Particular attention was paid to visual inspection of the automated formant tracking to make sure that they give the accurate formant tracking. Praat automated function was used to find the temporal mid point on the demarked regions and to list the values for first and second formants (F1 and F2, respectively) at this temporal mid point (Figure 10).



t̬i:iiT 'magic.performance\SG\NOM'

Figure 10. Segmentation procedure and temporal mid point location for measurements of vowel formants.

With syllables where vowels were preceded or followed by glides I have followed the same strategy in segmenting glide-vowel and vowel-glide sequences as that outlined above. For example, in syllables with complex onsets, if the first consonant was readily segmentable from the vocalic portion, I would place a mark at the onset of voicing. With glides in simple onsets I would also place a mark at the onset of voicing (beginning of the glide). I would then demark the offset of the vocalic portion of the syllable at the point of the decrease in the overall amplitude and cessation of formants, be that the end of the vowel portion or the end of the portion of a glide in coda position. In other words, I did not segment off the glides and the vowels.

The measurements in such cases were also made by hand. I have used Praat automated function to find the temporal mid point on the demarked vocalic portion (1/2 into the vocalic portion) individually for each token (Figure 11). The interval between this temporal mid point and the offset of voicing was taken as the interval

from which I drew the formant measurements for vowels preceded by glides. The formants in these syllables were measured at 3/4 temporal point into the vocalic portion (panel A). The interval between the onset of voicing and the temporal mid point was taken as the interval from which I drew the formant measurements for vowels followed by glides. The formants in these syllables were measured at 1/3 temporal point into the vocalic portion (panel B). The temporal mid point was used for measuring formants in syllables where vowels occurred between two glides.

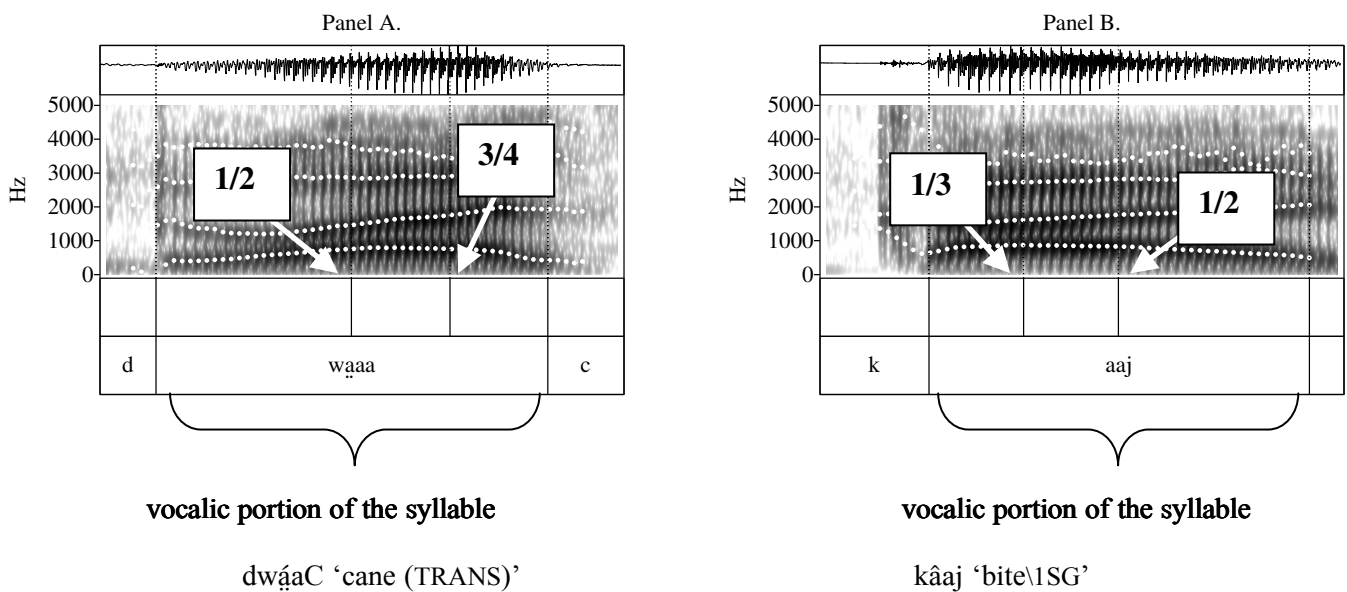


Figure 11. Segmentation procedure and temporal points location for measurements of vowel formants in syllables with glides at the onset position (panel A) and in coda position (panel B).

In other words, I took the 1/3 temporal point into the vowel-glide sequences, the 3/4 temporal point into the glide-vowel sequences, and 1/2 temporal point into the glide-vowel-glide sequences to represent the formants for the vowels. I compared the formant measurements taken at different temporal points in syllables with glides in onset and/or coda positions with the measurements for the same vowels in syllables with stops at the onset and coda positions. I found that the 1/3 temporal point for

vowel-glide, 3/4 temporal point for glide-vowel and 1/2 temporal point for glide-vowel-glide sequences accurately reflect the formants for a given vowel. On the other hand, the formant values taken at the temporal mid points in the examples in Figure 11, in most cases, did not reflect the formants of either the glide or the vowel. We can assume that the formants at the temporal mid-points in Figure 11 reflect the transitional phase between the two targets (glide and vowel, and vowel and glide, respectively). The problem with measuring formants of the vowels at 1/3 or 3/4 temporal points into the sequences is that this method is effective when the vowel is mid (VV) or long (VV), but it is not ideal for measuring short vowels (V) which can be as short as 30ms in duration.

The formant values for the first two formants were z-transformed to normalise for between-speaker variation (Clopper 2009).

5.3.2.2. Duration measurements

In measurements of vowel durations I have only included the syllables where the onset and coda consonants were easy to segment. The syllables where the vowels were flanked by glides, [fi], and some nasals in coda position were excluded from the measurements due to the unreliability of their segmentation (see previous section).

Turk, Nakai & Sugahara (2006) propose that in measuring vowel durations we must begin the measurements at the point of the release of the consonantal constrictions.

The release of the consonantal constrictions for voiced stops co-insides with the voice onset time (VOT) for the following vowel. When the vowel is preceded by a voiceless

(aspirated) stop, VOT does not begin at the release of the oral constriction, instead there is a burst of noise that precedes VOT. Turk, Nakai & Sugahara (2006) argue that measurements of the vowel after the voiceless stops should include the burst phase. I, however, measured all vowels from VOT. That is, I did not measure the burst phase. This way of measuring did not produce any differences between the duration of the vowels preceded by voiceless and voiced stops.

5.3.3. Results and discussion

5.3.3.1. Vowel and voice quality

The phonetic quality of modal and breathy voiced vowels is represented in Figure 12. The figure was created using the vowel plot in Remijsen & Manyang (2009) and in Remijsen & Mills (work in progress) as framework. Vowel characters in Figure 12 represent the mean value and the ellipses correspond to one standard deviation around the mean.

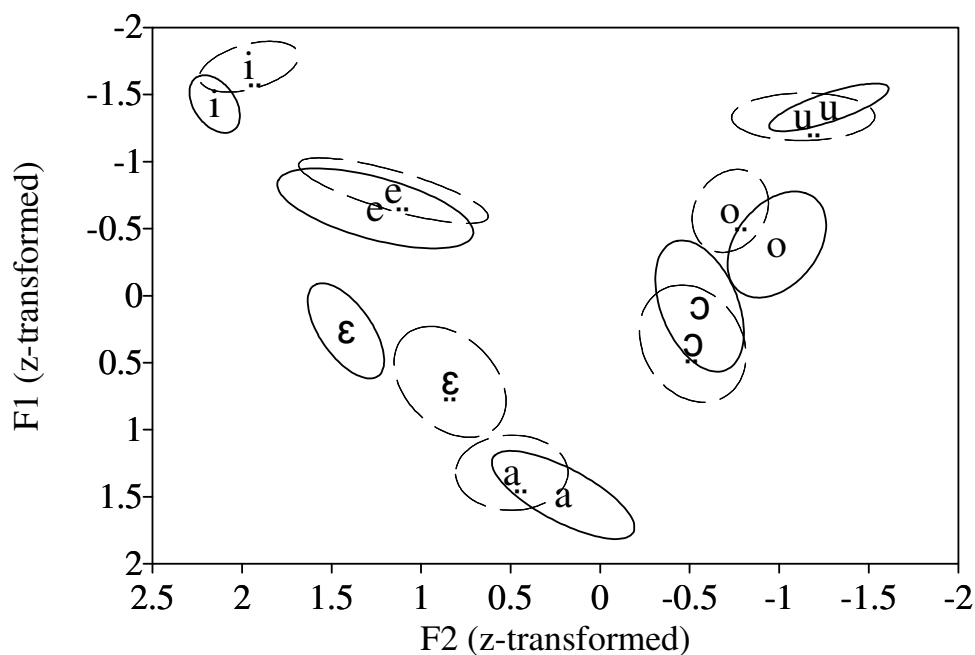


Figure 12. Thok Reel vowels. Z-transformed values for mean (vowel character) and standard deviation (ellipses) for the two voice qualities of the seven vowel phonemes. Solid line – modal voice, broken line – breathy voice.

Figure 12 shows that with the vowels /i, o/ F1 is higher for breathy vowels than for modal vowels, whilst with /ɛ/ the situation is the reverse – the modal /ɛ/ has higher F1 than the breathy /ɛ̥/ (see discussion in section 5.3.3.3). In addition, breathy /i̥, o̥, ɛ̥/ are more centralised than their modal counterparts. We can see that with the rest of the vowels /e, a, ɔ, u/ there is a considerable overlap in formant frequencies for breathy and modal phonemes. In Dinka, voice quality distinction correlates with F1 height, just as it is with the Thok Reel /i, o/ vowels. Malou (1988) and Remijsen & Manyang (2009) show that in Dinka F1 values are higher for breathy vowels than for modal vowels. The vowel chart for Dinka is given for comparison in panel A of Figure 13. We can see that in Dinka there is less overlap in the formant values for breathy and modal vowels as the breathy vowels tend to have higher F1. This difference in F1 for breathy and modal vowels in Dinka is reminiscent of the ATR distinction attested in

another related Western Nilotic language Shilluk (panel B). We can see that [+/-ATR] vowels in Shilluk differ in terms of F1 height.

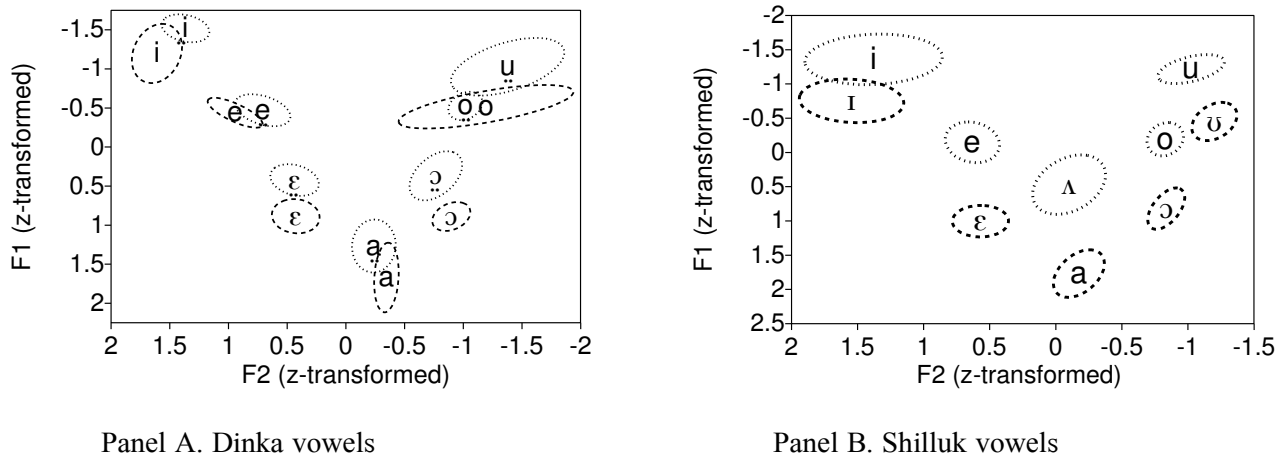


Figure 13. Dinka (panel A) and Shilluk (panel B) vowels. Figures from Mills and Remijsen (work in progress). Z-transformed values for means (vowel character) and standard deviations (ellipses). Panel A shows values for two voice qualities of the seven Dinka vowel phonemes: broken line – modal voice, dotted line – breathy voice. Panel B show the ATR distinction for Shilluk phonemes: broken line – [-ATR], dotted line – [+ATR].

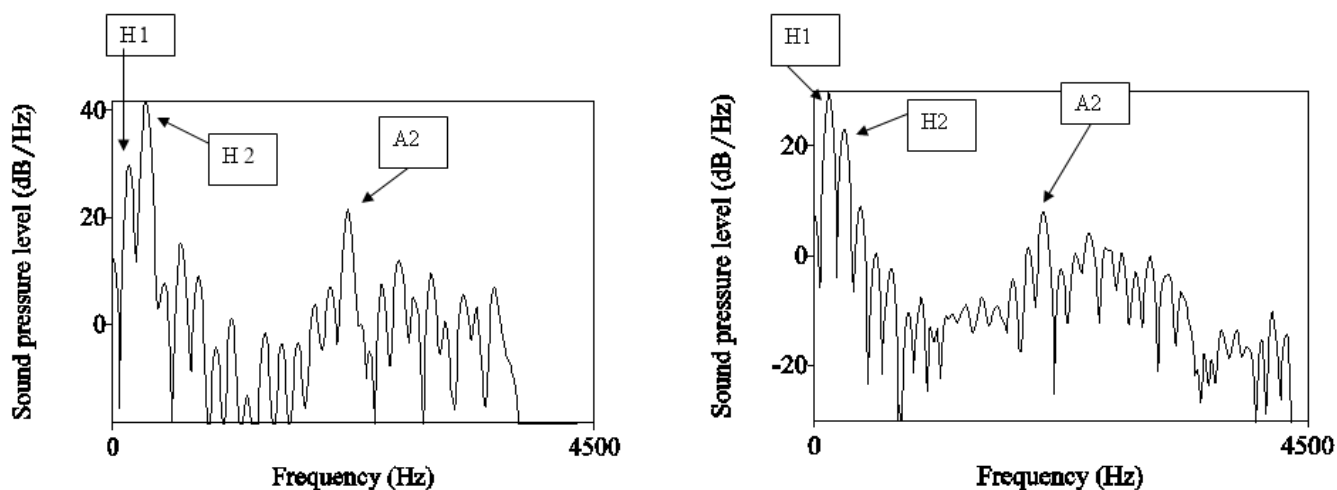
The overlap in formant frequencies for the majority of breathy and modal vowels in Thok Reel (Figure 12) shows that voice quality distinction for most phonemes is signalled solely by energy distribution (thank you to Bert Remijsen for pointing this out to me).

The relative energy distribution for breathy and modal vowels can be compared by considering frequency spectrum. Spectrum presents the information about the amplitude of the component frequencies at a given moment in time (Ladefoged 2003) which allows to measure the relative amount of energy in the higher and lower formants. Modal vowels have relatively more energy at higher frequencies than at lower frequencies as compared to breathy vowels which have relatively more energy

at lower frequencies than at higher frequencies. With breathy vowels we expect to see more energy in the fundamental frequency which corresponds to the first harmonic (H1).

One of the ways to measure the relative amplitude of the first harmonic is to compare its amplitude with the amplitude of the second harmonic (H2). In breathy voice H1 will be greater than H2 and in modal voice H2 will be greater than H1. Another way to measure the relative amplitude of H1 is to compare it with the amplitude of the harmonic most boosted by the second formant (A2). In breathy voice the amplitude of H1 will be greater than the amplitude of A2.

The relative energy distribution in a minimal pair for voice quality for Thok Reel vowel /i/ can be observed by examining spectrum in Figure 14. The arrows show the intensity level of the first harmonic (H1), the second harmonic (H2), and the harmonic boosted most by the second formant (A2). In modal voice (panel A), there is no much energy in the first harmonic, thus $H1 < H2$. In breathy voice (panel B), there is more energy in the first harmonic than in the second harmonic, thus $H1 > H2$. We can also see that the difference between H1 and A2 is greater in breathy voice than in modal voice. A detailed acoustic investigation of voice quality in Thok Reel is underway.



Panel A. Modal voice

Panel B. Breathy voice

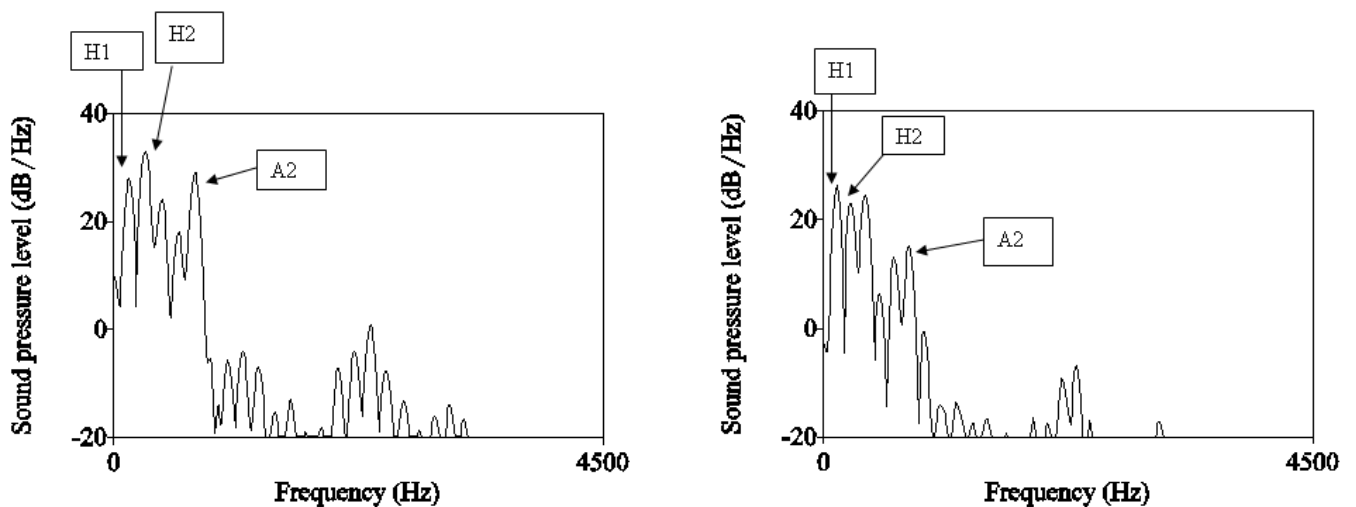
Figure 14. Spectrum representations calculated over a > 40 ms window centered on the temporal mid point of the vowel /i/ in modal-voiced b̥iir ‘spear\3SG’ (panel A), and breathy-voiced b̥iir ‘drum\3SG’ (panel B).

5.3.3.2. On voice quality distinction for /u/

In closely related Dinka and Nuer the high back vowel is always breathy (Malou 1988, Andersen 1987, Remijsen & Manyang 2009 for Dinka; and Yigezu 1995, Frank 1999 for Nuer). I hypothesise that in Thok Reel this vowel appears in two voice qualities on the basis of the evidence from the acoustic data. In this section I will present the acoustic evidence that supports the voice quality distinction for /u/ and discuss whether the evidence at hand is sufficient to firmly postulate a voice quality distinction for this phoneme.

Figure 15 shows spectrum for the minimal set for voice quality. The arrows show the intensity level of the first harmonic (H1), the second harmonic (H2) and the harmonic boosted most by the second formant (A2). In modal voice (panel A) there is no much

energy in the first harmonic, thus $H1 < H2$. In breathy voice (panel B) there is more energy in the first harmonic than in the second harmonic, thus $H1 > H2$. We can also see that there is no difference between the amplitude of H1 and A2 for modal voice quality, but for breathy voice quality H1 is greater than A2. These acoustic correlates support the observation that the words given in (29) constitute a minimal pair for voice quality.



Panel A. Modal voice

Panel B. Breathy voice

Figure 15. Spectrum representations calculated over a > 40 ms window centered on the temporal mid point of the vowel /u/ in modal-voiced gúuur ‘remove\3SG’ (panel A), and breathy-voiced gúuur ‘follow\AP\3SG’ (panel B).

Acoustic evidence given in this section suggests that in Thok Reel there is a voice quality distinction for the /u/ phoneme. However, whereas the breathy /u/ is found in all parts of speech, the distribution of the modal counterpart is restricted transitive verb stems, and more specifically, to the forms inflected for 2SG and 3SG subject: gúuur ‘remove\3SG’, gúuur-í ‘remove-2SG’ and bûul ‘roast\3SG’, bûul-í ‘roast-2SG’ (see section 5.4.1.1). The native speakers also tend to disagree about whether there is a

voice quality distinction for /u/. Therefore, I tentatively postulate that /u/ comes in two voice qualities. More data is required to clarify this issue in the future.

5.3.3.3. *On the acoustic realisation of breathy /ɛ̥/*

One further point that calls for a discussion is the the acoustic realisation of the vowel /ɛ̥/. We saw from Figure 12 that the breathy vowel is lower (F1) and more centralised (F2) than its modal counterpart. In fact, the formant frequencies for /ɛ̥/ are fairly close to that for /ḁ/. Perceptually it is often difficult to tell the difference between the breathy /ḁ/ and /ɛ̥/. Moreover, the vowel /ɛ̥/ can vary in its realisation – in some renditions it is perceived as more /ɛ̥/-like and in other renditions as more /ḁ/-like. This is especially true for some of the words, such as those given in (31). We can see that the vowel can be short (31a), mid length (31b) or long (31c). Thus, vowel length does not correlate with the perceived variation in the realisation of the vowel.

- | | | | |
|------|-------|------------|-----------------|
| (31) | a. | l̥ɛ̥ŋ | ‘good\SG’ |
| | | k̥ɛ̥C | ‘bite\R\3SG’ |
| | b. | l̥ɛ̥jɛ̥ | ‘animal\PL\GEN’ |
| | ŋ̥ɛ̥C | ‘milk\3SG’ | |
| | c. | l̥ɛ̥ɛ̥ŋ | ‘good\PL\PRED’ |
| | | ŋ̥ɛ̥ɛ̥C | ‘milk\AP\3SG’ |

Evidence for the distinction between /ɛ̥/ and /ḁ/ is the presence of minimal and near-minimal pairs given in (32). I personally find it very difficult to tell the pairs in (32) apart. The native speakers also tend to disagree about the quality of these vowels. The

averaged measurements for the two first formants (F1 and F2) for the vowels in in (32) are given in (33). Measurements were taken from these words uttered by a male speaker JRK (one of the speakers whose vowels were measured to plot the vowel space in Figure 12). We can see that /a/ is lower (F1) and more centralised (F2) than /ɛ/. This is compatible with the distribution of these phonememes in the vowel space presented in Figure 12.

(32)	a.	kɛ̣C	‘bite\R\3SG’	~	kɔ̣C	‘bite\R\1SG’
	b.	ŋɛ̣C	‘milk\3SG’	~	ŋɔ̣C	‘milk\1SG’
	c.	lɛ̣ɛ̣ɛ̣	‘good\PL\PRED’	~	lɔ̣ɔ̣ɔ̣	‘good\PL\ATTR’

(33)		F1	F2
	ɛ̣	599	1838
	a	712	1520

5.3.3.4. Vowel length

Figure 16 presents means (dots), and standard deviations (whiskers) for the durations of short, mid and long vowels. We can see that the duration means for the three vowel lengths are well separated and there is no overlap in standard deviations. Mean values for the vowels are 77ms (V), 123ms (VV), and 205ms (VVV). Compatible findings are presented in Remijsen & Gilley (2008) for Dinka.

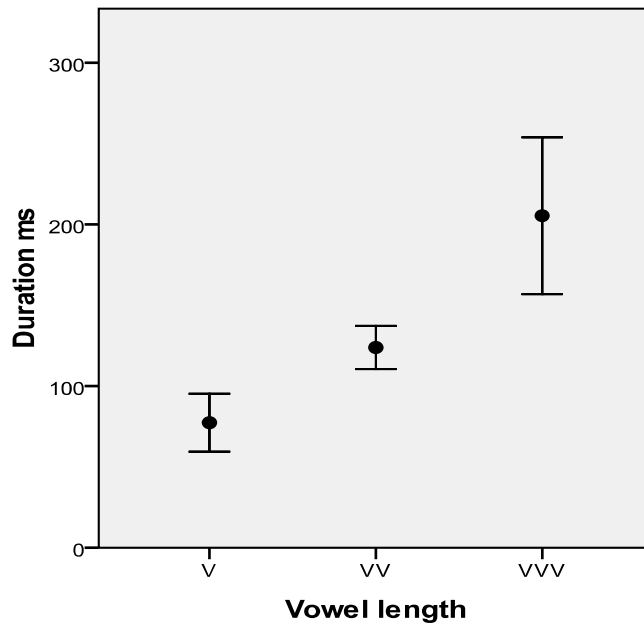


Figure 16. Means (dots) and standard deviations (whiskers) for durations of Thok Reel vowels. V – short vowel, VV – mid vowel, VVV – long vowel.

5.3.3.5. Summary

In conclusion to this section, we saw that the seven vowel phonemes combine with the suprasegmental distinctions – voice quality and vowel length. Both vowel quality and vowel length are phonemic in Thok Reel. We saw that these distinctions serve to distinguish lexical items and to signal morphological distinctions. The two-way voice quality distinction, modal and breathy, with most vowel phonemes is signalled by energy distribution, whilst with other vowels the formant frequencies are also employed to signal the distinction between modal and breathy vowels. I have postulated a phonemic voice quality distinction for /u/. The evidence for the distinction comes from the minimal pairs and from the acoustic data. Because the occurrence of the modal /u/ is restricted to transitive verb stems, and the native-

speaker intuitions about the voice quality distinction for this vowel vary, the proposed distinction is tentative. Therefore, more data and, perhaps, some perception experiments, will be required to either verify or to refute my analysis. We saw that the breathy vowel /ɛ̤/ is lower and more centralised than the modal /ɛ/. The vowel /ɛ̤/ is so fairly close to /a̤/, so that it is difficult to tell these vowels apart in some of the words in which they occur. I have shown that in minimal pairs for the three phonological lengths of /ɛ̤/ and /a̤/ the formant frequencies are kept apart. Because the native speakers tend to disagree about the quality of the vowels in such cases, one of the directions for future research will be to run some perception experiments with the native speakers. I have also shown that there is a phonemic three-way vowel length distinction. The averaged durations for the vowels measured across various prosodic contexts are 77ms (V), 123ms (VV) and 205ms (VVV).

5.4. Morphophonological vowel alternations in verb paradigms

In this section I will give a descriptive account of vowel alternations involved in stem-internal morphological inflection in verbs. Under the discussion will be vowel alternations involved in subject agreement marking in finite verbs. The scope of the investigation will be restricted to transitive and antipassive verbs in simple declarative sentences. At this point I will say nothing about vowel alternations involved in derivational morphology (e.g. derivation of the antipassive from transitive).

The discussion will proceed as follows: in section 5.4.1 I will give a description of vowel and voice quality alternations and in section 5.4.2 I will give a description of vowel length alternations. Following the discussions in each of these sections I will compare my findings on vowel alternations in Thok Reel with the descriptions of these phenomena in Dinka and Shilluk as they appear in Andersen (1990, 1993), Remijsen & Gilley (2008) and Remijsen et al. (2009).

5.4.1. Vowel and voice quality alternations

In the discussion on voice and vowel quality alternations I will first give a description of the alternations in the transitive verb stems 5.4.1.1 and then in the antipassive verb stems 5.4.1.2. I will show that voice and vowel quality alternations in transitive and antipassive verb stems follow a set of rules that I describe as vowel lowering. I will argue that the antipassive stems exhibit a much more complex behaviour than the transitive stems, and that in order to explain voice and vowel quality alternations in the antipassive we must consider the corresponding transitive forms. At the end of the

discussion I will give some brief comparative remarks on vowel and voice quality alternations in transitive verbs in Thok Reel and Agar dialect of Dinka (Andersen 1993).

5.4.1.1. Transitive verbs

Table 3 gives a summary of vowel and voice quality values of the stem vowels in person-number paradigms in transitive verbs.

Table 3. Vowel and voice quality of the stem vowels in person-number paradigms of transitive verbs.

	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.
1SG	jɛ̣	ɛ	e	a	ɶ	a	ɶ	a	ɶ	ɔ / a	o	wɔ	wɔ̣
2SG	ị	e	ẹ	ɛ	ɛ̣	a	ɶ	ɔ	ɔ̣	o	ọ	u	ụ
3SG	ị	e	ẹ	ɛ	ɛ̣	a	ɶ	ɔ	ɔ̣	o	ọ	u	ụ
1PL.INCL	jɛ̣	ɛ	e	a	ɶ	a	ɶ	a	ɶ	ɔ / a	o	wɔ	wɔ̣
1PL.EXCL	jɛ̣	ɛ	e	a	ɶ	a	ɶ	a	ɶ	ɔ / a	o	wɔ	wɔ̣
2PL	jɛ̣	ɛ	e	a	ɶ	a	ɶ	a	ɶ	ɔ / a	o	wɔ	wɔ̣
3PL	jɛ̣	ɛ	e	a	ɶ	a	ɶ	a	ɶ	ɔ / a	o	wɔ	wɔ̣

The number of different vowel and voice qualities within a paradigm varies from one (columns 6-7) and two (the rest of the columns). Forms inflected for 2-3SG subject show a uniform behaviour with respect to voice and vowel quality. With the exception of columns 6-7, forms inflected for 2-3SG subject differ from the rest of the paradigmatic forms, those inflected for 1SG and 1-3PL subject. The forms inflected for 1SG and 1-3PL subject also show a uniform behaviour with respect to vowel and voice quality. Table 3, therefore, can be reduced to just two rows (Table 4) – one that gives the value of stem vowels in 2-3SG forms and another that gives the value of the

stem vowels in 1SG and 1-3PL (elsewhere). Note that the basic vowel /i/ does not occur in Table 3. This could be an accidental gap in my data (see section 5.4.1.3).

Table 4. Summary of vowel and voice quality alternations in person-number paradigms of transitive verbs.

	1.	2.	3.	4.	5.	7.	8.	9.	10.	11.	12.	13.	14.
2-3SG	i̇	e	ė	ε	ε̇	a	ȧ	ɔ	ɔ̇	o	ȯ	u	u̇
elsewhere	jε̇	ε	e	a	ȧ	a	ȧ	a	ȧ	a / ɔ	o	wɔ	wɔ̇

The first question that we need to address with regards to vowel and voice quality alternations is about the direction of the alternations. In other words, which forms can be considered as basic with respect to vowel and voice quality values and which are derived? Observe that in some cases the vowel quality in 2-3SG forms cannot be predicted from the vowel quality in the rest of the paradigmatic forms. For example, where the forms other than 2-3SG have /a/ the corresponding 2-3SG forms have /ε̇/, /ȧ/, and /ɔ̇/ (columns 5, 8 and 10, respectively). Similarly, where the forms other than 2-3SG have /a/, the 2-3SG forms have /ε/, /a/, /ɔ/ and /o/ (columns 4, 7, 9 and 11, respectively). In these cases it is not possible to predict the value of the vowels in stems inflected for 2-3SG subject by considering the value of the vowels in the rest of the forms. In what follows I will show that it is possible to predict the value of the stem-internal vowels in stems inflected for 1SG and 1-3PL subjects by considering the stem vowels in forms inflected for 2-3SG. Therefore, I will treat the 2-3SG forms as basic with respect to voice and vowel quality.

In all examples that will be presented in this section I will give 3SG and 1PL (EXCL -kə̇ and INLC -kən, represented as -kə̇(n)) forms to represent the basic and the derived values, respectively.

Except for the basic low vowel (whether breathy or creaky), which does not alternate (Table 4, columns 7 and 8), the stem vowels show the following alternations: vowel breaking (Table 4 columns 1, 13 and 14), voice quality alternations (Table 4 columns 3 and 12), and vowel quality alternations (Table 4 columns 2, 4, 5, 9, 10 and 11). I categorise these alternations as vowel lowering (also see Andersen 1993 for the description of similar processes in Dinka). Whilst it is easy to see how vowel breaking and vowel quality alternations can be thought of as vowel lowering processes, it is not readily observable how voice quality alternations can also be considered as vowel lowering. The argumentation for treating all the alternations as vowel lowering is given in the discussion below.

The most common type of the alternations involves lowering of the basic vowel by one vowel quality position. The voice quality of the basic vowel remains unchanged in these cases. Vowel lowering applies to the basic vowels /e, ε, ɛ̃, ɔ, ɔ̃/ in (34).

(34) e → ε

		‘dig’	‘count’	‘turn’
3SG	tèT	kwéen	wél	
1PL	téT-kò(n)	kwén-kò(n)	wél-kò(n)	

ε → a

ε̣ → ạ

		‘know’	‘distribute’	‘kill’
3SG	ɲèC	dɛ̣ɛw	nɛ̣ɛw	
1PL	ɲáC-kò(n)	dáaw-kò(n)	náK-kò(n)	

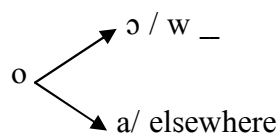
ɔ → a

ɔ̣ → ạ

		‘put into the mouth’	‘pound’
3SG	ɲjòom	ʔɔ̣ɔl	
1PL	ɲjáam-kò(n)	ʔáal-kò(n)	

In the case of /o/ the alternation is phonologically conditioned. /o/ is lowered by one quality position, to /ɔ/, if it is preceded by a glide /w/ (35a), otherwise it is lowered by two quality positions to /a/ (35b).

(35)



	a. ‘bury’	b. ‘take (somewhere)’
3SG	kwóɲ	nóoɲ
1PL	kwóɲ-kò(n)	náɲ-kò(n)

The high vowels exhibit vowel breaking, whereby the vowel becomes a diphthong.

Note that I treat these sequences as phonological glide-vowel (see section 4.3.1).

Vowel breaking involves lowering the vowel by two vowel quality positions (36).

Thus, in the case of /u/ it becomes /wɔ/ and not */wo/ and in the case if /i/ it becomes /jɛ/ not */je/.

(36) u → wɔ

u → wɔ

		‘roast’		‘finish’
3SG	bûul			rúum
1PL	bwôl-kò(n)			rwòm-kò(n)

i → jɛ

		‘punch’		‘feed’		‘bump’
3SG	píim			mìiiT		tíiT
1PL	pjéem-kò(n)			mjéεT-kò(n)		tjéT-kò(n)

The change in voice quality is only observed with two breathy vowels /ɛ/ and /ɔ/ (37).

Bert Remijsen (p.c.) notes that voice quality alternation in these cases is compatible with vowel lowering analysis, as breathy /ɛ, ɔ/ tend to have higher F1 (acoustic correlate of vowel height) than the modal counterparts (see Figure 12 in section 5.3.3.1). Thus, these voice quality alternations are also considered to be processes of vowel lowering.

(37) ɛ → e

		‘awaken (someone)’		‘prevent’
3SG	kéer			péeen
1PL	kéer-kò(n)			péeen-kò(n)

ɔ → o

		‘hate’		‘bring’
3SG	lɔow			nòooŋ
1PL	lóK-kò(n)			nóooŋ-kò(n)

We saw that in the transitive paradigms the number of different vowel and voice qualities varies from one to two. I have argued that the forms inflected for 2-3SG subject are basic with respect to voice and vowel quality, and the values of the vowels in the rest of the paradigmatic forms can be derived from these basic values. The alternations involve changes in vowel quality (34-35), voice quality (37) and the process of vowel breaking (36), all of which are said to be the processes of vowel lowering. In addition, we saw that with the basic vowel /o/ the alternation is phonologically conditioned (35).

5.4.1.2. Antipassive verbs

In the antipassive paradigms we can also distinguish between the forms inflected for 2-3SG and the rest in terms of the behaviour of stem vowels. I will assume that the stem vowels in 2-3SG forms are also basic with respect to vowel and voice quality values. Table 5 gives a summary of all attested alternations in the antipassive paradigms. Observe that basic vowels /i, e, ε, ʌ, o, u/ do not occur in the table. These gaps will be discussed in section 5.4.3.1.

Table 5. Summary of vowel and voice quality alternations in person-number paradigms of antipassive verbs.

	1.	2.	3.	4.	5.	6.	7.	8.
2-3SG (basic)	i̇	ė	ε̇	a	ɔ	ɔ̇	ȯ	u̇
elsewhere	jε̇	ė / e	ε̇ / ʌ̇	a	ɔ / a	ɔ̇ / ʌ̇	ȯ / o	wɔ̇ / wɔ̇

Table 5 shows that in the antipassive there are some alternations (38a) which we have observed in the transitive paradigms (34-37), but there are also the alternations which are not found in the transitive (38b). All alternations in (38) can again be described as vowel lowering processes.

(38) AP

a.	$i \rightarrow j\varepsilon$	$\varepsilon \rightarrow a$	$\varepsilon \rightarrow a$	$e \rightarrow e$	$\varepsilon \rightarrow o$
	‘feed\AP’	‘cane\AP’	‘pound\AP’	‘search.by.parting\AP’	‘bring\AP’
3SG	míT	dwéεεC	ʔɔT	wéeer	nóooŋ
2PL	mjíT-èj	dwáaaC-èj	ʔáaT-èj	wéeer-èj	nóooŋ-èj
b.	$u \rightarrow w\varepsilon$	$u \rightarrow w\varepsilon$			
	‘roast\AP’	‘blow\AP’			
3SG	bùul	kúuuT			
2PL	bwòol-èj	kwóooT-èj			

The availability of more than one vowel symbol in the bottom row of Table 5 is due to the reason that in some cases no vowel lowering takes place in the antipassive.

Vowel and voice quality of the stem vowels in the antipassive can be identical in all of the paradigmatic forms. Whether or not vowel lowering will occur in the antipassive cannot be predicted by examining the context in which the vowels occur. Consider (39) where the stem vowels occur in identical context. The 3SG forms in (39a) and (39b) are homophones. The 2PL forms, however, differ in terms of voice quality of the stem vowel. In (39a) the vowel in 2PL form is lowered (modal /e/), but no vowel lowering occurs in 2PL in (39b).

(39)	3SG	2PL	
a.	wéeer	~ wéeer-èj	‘search.by.parting\AP’
b.	wéeer	~ wéeer-èj	‘change\AP’

In paradigms where vowel lowering takes place, it is not always possible to predict which of the forms inflected for 1SG and 1-3PL will have a lowered stem vowel. Most often, the lowered vowel occurs in stems inflected for 2PL subject. The 2PL can be the only form within its a paradigm that exhibits vowel lowering (40a); or it can be one of the forms that exhibit vowel lowering (40b).

(40)	3SG	1SG	1PL	2PL	3PL	
a.	dɛ̃ɛw	dɛ̃ɛw-ɛ̃	dɛ̃ɛw-kò(n)	dâaw-èj	dɛ̃ɛw	‘distribute\AP’
b.	ɲɛ̃ɛɛC	ɲâaaC-ɛ̃	ɲâaC-kò(n)	ɲâaaC-èj	ɲɛ̃ɛɛC	‘milk\AP’
	dɛ̃ɛw	dâaw-ɛ̃	dâaw-kò(n)	dâaw-èj	dâaw	‘separate\AP’

In addition, in some paradigms, forms inflected for 1SG and 1-3PL can have two alternative forms that are equally acceptable (41). Again, most often these alternative forms are found in 2PL.

(41)	3SG	1SG	1PL	2PL	
a.	míT̄	míT̄-ɛ̃	míT̄-kò(n)	míT̄-èj mjɛ̃T̄-èj	‘feed\AP’
b.	kúuj̄	kúuj̄-ɛ̃ kwóoj̄-ɛ̃	kúuj̄-kò(n)	kúuj̄-èj kwóoj̄-èj	‘bury\AP’
c.	ʔɔ̃T̄	ʔɔ̃T̄-ɛ̃	ʔɔ̃T̄-kò(n) ʔâaT̄-kò(n)	ʔɔ̃T̄-èj ʔâaT̄-èj	‘pound\AP’

In fact, for 2PL, the form that exhibits vowel lowering was always given as the first choice by the language consultants. Less frequently, forms that exhibit vowel lowering

were given as the first choice for 1SG and 1PL forms and almost never for 3PL. No forms with lowered vowels were ever given for 2-3SG forms.

In what follows I will argue that in order to explain the application or non-application of vowel lowering in the antipassive verb stems we must consider the stem vowels in the corresponding transitive paradigms. I will claim that the non-application of vowel lowering in the antipassive only occurs in cases where the value of the derived vowel of the transitive cannot be derived from the basic vowel in the antipassive.

Consider examples in (42). Earlier I have said that the stem vowels in (42a-b) occur in an identical context, which means it is not possible to explain why vowel lowering applies in 2PL form in (42a) and does not apply in 2PL form in (42b). If the derivation only considered the basic vowel in the antipassive, then both 2PL forms would have undergone lowering. Now, consider the corresponding 2PL transitive forms in (43). We can see that the stem vowel is /e/ in (43a) and /a/ in (43b).

(42)	a. ‘search.by.parting\AP’	b. ‘change\AP’
AP\3SG	wé _̣ eer	wé _̣ eer
AP-2PL	wé _̣ eer-èj	wé _̣ eer-èj
(43)	a. ‘search.by.parting’	b. ‘change’
TRANS-2PL	wé _̣ er-èj	wá _̣ aar-èj

Let us assume that the value of the lowered vowel in the antipassive must match the value of the vowel in the corresponding transitive forms. The 2PL forms of the antipassive (42a) and transitive (43a) indeed have the same vowel and voice quality values. But the stem vowels in 2PL in (42b) and (43b) differ, it is /ẹ/ in (42b) and /a/

in (43b). So, if our assumption is correct, why do we get the identical vowel values in (42a) and (43a) but not in (42b) and (43b)? The answer is that the value of the stem vowel in (43a) can be derived from the basic vowel in (42a) by the application of the rule given in (37), namely /ɛ̄ → e/. By contrast, the value of the stem vowel in (43b) cannot be derived from the basic vowel in (42b) since there is no rule that permits the following alternation */ɛ̄ → a/. Viewing the examples in (42) in this way can explain the apparent irregularity in the application and non-application of vowel lowering in the antipassive.

Other cases where vowel lowering fails to apply are presented in (44). We can see that the non-application of vowel lowering in the antipassive is inexplicable if we only consider the antipassive forms. In all cases in (44), vowel lowering could have applied if the process of vowel lowering was an independent process that only considered the value of the basic vowel in the antipassive. These processes would have been /ɔ̄ → o/ in (44a-b), /ɛ̄ → e/ in (44c-d), and /ɛ̄ → a/ in (44e). Examples in (45) show that these processes apply in other antipassive paradigms.

(44)		3SG	2PL	
a.		lwóoj	lwóoj-èj	‘work\AP’
b.		nòoŋ	nòoŋ-èj	‘take\AP’
c.		tèt	tèt-èj	‘dig\AP’
d.		njéer	njéer-èj	‘like\AP’
e.		léεεK	léεεK-èj	‘insult\AP’

(45)		3SG	2PL	
a.	/ɔ̄ → o/	nóooŋ	nóooŋ-èj	‘bring\AP’
b.	/ɛ̄ → e/	wéer	wéer-èj	‘search.by.parting\AP’
c.	/ɛ̄ → a/	kéεεP	káaaP-èj	‘hold\AP’

The non-application of vowel lowering in the antipassive forms in (44) and the application of vowel lowering in (45) can be explained if we consider them together with the corresponding transitive forms (46) and (47), respectively. We can see that in the antipassive paradigms in (47) the value of vowels derived by the rules in (34) and (37) matches the values of the vowels in the corresponding transitive forms, or the derived vowel in the transitive. By contrast, the application of the same rules in (46) would render a vowel value different from that in the corresponding transitive forms.

(46)	AP\3SG	AP-2PL	TRANS-2PL	
a.	lwóoj	lwóoj-èj	lwóoj-èj	‘work’
b.	nòoŋ	nòoŋ-èj	náŋ-èj	‘take’
c.	tèt	tèt-èj	tét-èj	‘dig’
d.	njéer	njéer-èj	njáaar-èj	‘like’
e.	léεεK	léεεK-èj	láaaK-èj	‘insult’

(47)	AP\3SG	AP-2PL	TRANS-2PL	
a.	nóooŋ	nóooŋ-èj	nóooŋ-èj	‘bring’
b.	wéeer	wéeer-èj	wéer-èj	‘search.by.parting’
c.	kéεεP	káaaP-èj	káaaP-èj	‘hold’

Because the vowels in the antipassive appear to alternate only when the value of the lowered vowel would match the value of the derived vowel in the transitive, I claim that for vowel lowering to take place in the antipassive, two conditions must be met:

(48) Vowel lowering in the antipassive paradigms

1. The vowel must be derived from the basic vowel in the antipassive by the application of one of the rules given in (34-37), and additional rules given in (38b).
2. The derived vowel must have the same voice and vowel quality value as the vowel in the corresponding transitive forms (in most cases, the derived vowel in transitive).

For the antipassive forms in (46) to have the same stem vowel as in the corresponding transitive forms, the following processes must apply: */ o → o / in (46a), */ o → a / in (46b), */ e → e / in (46c), */ e → a / in (46d) and */ e → a / in (46e). All of these processes would require vowel quality and voice quality change and none of these processes are attested in Thok Reel (cf. 34-37). The application of these processes would violate the first condition in (48) which tells us that the vowels must be derived by application of one of the rules in (34-37). And conversely, we saw that the vowel values derived by the application of the rules in (34-37) to the basic vowel in the antipassive in (46) would not result in the same vowel value as that in the corresponding transitive, hence, the second condition in (48) is not met.

Because the value of the lowered vowel in the antipassive has to match the value of the vowel in the corresponding transitive forms, this process could be thought of as vowel copying. But this copying can only take place if it would not result in a vowel value that cannot be derived from the basic vowel in the antipassive by application of one of the rules given in (34-37).

In summary, we saw that it is possible to predict in which paradigms vowel lowering will not occur. When the value of the derived vowel in the transitive paradigm can not

be derived from the basic vowel in the corresponding antipassive by application of one of the rules described in (in section 5.4.1.1), no vowel lowering will take place in the antipassive.

Another possibility that we have to consider in relation to the processes of vowel lowering in the antipassive is that the lowering would fail to apply if it will result in homophony of the transitive and the antipassive forms (a possibility suggested to me by Bert Remijsen). Assuming that the non-application of vowel lowering in the antipassive is due homophony avoidance is not supported by the data as there are cases where vowel lowering in the antipassive forms results in homophony with the corresponding transitive forms (47a, c).

So far I have not discussed vowel lowering in the antipassive paradigms with the basic vowel /u/. Recall that so far, I have not found the modal /u/ outside transitive paradigms (see section 5.3.3.2), so the antipassive forms invariably have breathy basic /u/. In these paradigms vowel lowering proceeds along the same lines as outlined above only if the basic vowels in transitive and antipassive have the same vowel quality (49). In this example the forms inflected for 2-3SG subject (basic vowel) have the same vowel quality but differ in terms of voice quality. The vowel is modal in the transitive and breathy in the antipassive. In (50) the basic vowel in the antipassive is /u/ and the basic vowel in the transitive is /o/. The values of the derived vowels in (50) are /ɔ/ in the transitive and /o/ in the antipassive. Clearly, in (50) vowel lowering in the antipassive takes the vowel quality value of the basic vowel and not of the derived vowel in the transitive. Here again, the vowels in the antipassive and transitive forms differ in terms of voice quality.

(49)		‘roast’	
		AP	TRANS
	3SG	bùul	bûul
	2PL	bwòol-èj	bwôol-èj

(50)		‘bury’	
		AP	TRANS
	3SG	kùujɲ	kwóɲ
	2PL	kwóɔɲ-èj	kwóɲ-èj

On the basis of the examples in (49-50) I hypothesise that with the basic /ɨ/ in the antipassive paradigms, the lowered vowel will match the vowel quality of the derived vowel in the corresponding transitive paradigm if the transitive and the antipassive have the same vowel quality of the basic vowel. Otherwise, the vowel quality of the derived vowel in the antipassive will match the vowel quality of the basic vowel in the transitive.

The analysis of the vowel and voice quality alternations in the antipassive paradigms has almost caught up with the presented data. Two further points need to be commented on. First is regarding the distribution of the forms that exhibit vowel lowering in a paradigm. Recall that the number of the inflected forms that appear with lowered vowels within a paradigm can vary. In (51a) only the 2PL has the lowered stem vowel, in (51b) 1SG and 1-2PL forms appear with lowered stem vowels and in (51c) 1SG and 1-3PL forms appear with lowered stem vowels.

(51)	3SG	1SG	1PL	2PL	3PL	
a.	dɛ̃ɛw	dɛ̃ɛw-ɛ̃	dɛ̃ɛw-kò(n)	dâaw-èj	dɛ̃ɛw	‘distribute\AP’
b.	ɲɛ̃ɛɛC	ɲâaaC-ɛ̃	ɲâaC-kò(n)	ɲâaaC-èj	ɲɛ̃ɛɛC	‘milk\AP’
c.	dɛ̃ɛw	dâaw-ɛ̃	dâaw-kò(n)	dâaw-èj	dâaw	‘separate\AP’

The second point is the availability of the alternative forms for a given inflectional category. Recall that in some paradigms two alternative forms can be found for, for example, 1-2PL antipassive forms (52). The alternative forms differ only in terms of the values of the stem-internal vowel. One of the forms has the value of the basic vowel in the antipassive (see 3SG form), and another form appears with the lowered vowel.

(52)

	a. ‘pound’		b. ‘hold’	
	TRANS	AP	TRANS	AP
3SG	ʔɔ̃ɔɔl	ʔɔ̃t	kɛ̃ɛɛP	kɛ̃ɛɛP
1PL	ʔâal-kò(n)	ʔɔ̃T-kò(n) ʔâaT-kò(n)	kâaP-kò(n)	kɛ̃ɛP-kò(n)
2PL	ʔâaal-èj	ʔɔ̃T-èj ʔâaT-èj	kâaaP-èj	kɛ̃ɛP-èj kâaaP-èj

I hypothesise that for most antipassive paradigms two alternative forms are available for all forms except 2-3SG. The forms differ in terms of vowel quality and/or voice quality of the stem vowel, just as it is in (52). The paradigms that lack the alternative forms are those where vowel lowering would yield unacceptable values (see the two conditions in (48)). The reason that this is not reflected in my data is likely to be due

to the fact that I did not elicit all the options. The alternative forms like that in (52) came up during different elicitation sessions and were confirmed to be equally acceptable (though the forms that have the same vowel value as the 2-3SG antipassive forms were said to be the ‘better options’). I, however, did not explicitly ask my language consultants about whether the alternative forms are available for every relevant form and in every relevant paradigm. The line of the future research, therefore will be to test this hypothesis by explicitly asking about the possibility of having alternative forms in the antipassive. The prediction that I make is that the forms that exhibit vowel lowering will be available for all paradigms where the lowered vowel will not violate the two conditions in (48).

I have argued that in order to explain the application or non-application of vowel lowering in the antipassive two things have to be taken into considerations. First, the value of the derived vowel in the transitive forms. Second, vowel lowering will only take place in the antipassive if the value of the derived vowel in the corresponding transitive paradigm can be derived from the basic vowel in the antipassive by one of the rules given in (34-37), unless the basic vowel in the antipassive is /ɨ/. If the value of the derived vowel in the transitive cannot be derived from the basic vowel in the antipassive, no vowel lowering will take place in the antipassive. With /ɨ/, the lowered vowel will match the vowel quality of the derived vowel in the corresponding transitive paradigm if the transitive and the antipassive have the same vowel quality of the basic vowel, otherwise, the vowel quality of the derived vowel in the antipassive will match the vowel quality of the basic vowel in transitive.

5.4.1.3. Comparative perspective and final remarks

We saw that vowel alternations in transitive and antipassive paradigms can be explained in terms of vowel lowering. In transitive paradigms this process is fairly straightforward: the lowered vowel can be derived from the basic vowel, as it appears in 2-3SG forms, by application of the processes stated in (34-37). In the antipassive paradigms the situation is more complex. First, the inflected forms where vowel lowering can take place (1SG, 1-3PL) have alternative forms that contain the basic vowel. Second, the value of the lowered vowel has to match the value of the vowel in the transitive forms (in most cases, the value of the derived vowel in transitive), and it must be possible to derive this value from the basic vowel in the antipassive by applying one of the rules given in (34-37) and in (38b).

Clearly, vowel and voice quality alternations in the antipassive paradigms are more complex than that in the transitive paradigms. Researchers working on related languages like Dinka (Andersen 1993) and Shilluk (Miller 2008, Remijsen, p.c.) have also commented on the fact that the antipassive verbs exhibit a more complex behaviour than the transitive verbs. So far, I have not come across studies of the related languages that give a description of vowel and voice quality alternations in the antipassive verbs. For this reason, voice and vowel quality alternations in the antipassive paradigms in Thok Reel cannot be compared with the behaviour of the stem vowels in the antipassive paradigms in related languages. Morphophonology of transitive verbs in related languages, by contrast, has been relatively well studied. In what follows I will compare the findings of the present study with the findings on vowel quality alternations in finite transitive verbs in Agar Dinka (Andersen 1993). One of the main differences between the vowel alternations in Dinka and Thok Reel is

that in Dinka there are alternations in vowel quality but not in voice quality. Modal vowels only alternate with modal vowels and breathy vowels only alternate with breathy vowels. We saw that in Thok Reel basic vowels /e/ and /o/ alternate with the modal counterparts. Another difference between the alternations in Dinka and Thok Reel is the number of different alternations within a paradigm. We saw that in Thok Reel the number of different voice and vowel qualities within a paradigm is maximally two. In Dinka, the number of different vowel qualities is maximally three, though in most cases there are just two different voice and vowel qualities within a paradigm.

To this must be added that Andersen's findings are based on the data from 500 transitive verb paradigms, whereas my analysis of the transitive verbs is based on the data from 51 paradigms. This relatively small data set could be responsible for the absence of the basic /i/ in the transitive verb stems. Similarly, the basic vowels /i, e, ε, a, o, u/ do not occur in the 49 antipassive paradigms that I have examined. Additional explanation for these gaps could be that these vowels do not occur in the antipassive paradigms (e.g. /u/ is restricted to the transitive stems). More data is required in order to determine if these gaps are accidental or systematic.

An aspect that I have not covered in this thesis is vowel and voice quality alternations that are involved in the derivation of the antipassive verbs from transitive. The investigation into the derivational morphology is underway.

5.4.2. Vowel length alternations in verb paradigms

In this section I will present a descriptive analysis of vowel length alternations in verb paradigms. I will give an overview of the data for transitive and antipassive paradigms (section 5.4.2.1) and present an analysis of the alternations (section 5.4.2.2). The alternations will be analysed as vowel lengthening. I will show that unlike with vowel and voice quality alternations, the antipassive verbs exhibit a much simpler behaviour with respect to vowel length alternations than the transitive verbs. In section 5.4.2.3 I will compare the findings presented here with the findings on vowel length alternations in two closely-related languages Dinka and Shilluk (Andersen 1990; Remijsen and Gilley 2008; Remijsen et al. 2009).

5.4.2.1. Overview of the data

Transitive paradigms

Transitive verb paradigms can be divided into two groups based on the presence/absence of vowel length alternations. The verbs that fall into the first group exhibit vowel length alternations within paradigms. The verbs that fall into the second group show no alternation – the paradigmatic forms do not differ with respect to vowel length of the stem-internal vowels.

Within the alternating group, the alternations are between short and mid vowels $V \sim VV$ (53), and mid and long vowels $VV \sim VVV$ (54). In my data there are also two lexical stems where short vowels alternate with long vowels $V \sim VVV$ (55).

(53)		‘finish’	‘vomit’	‘count’
	1SG	rwɔ̃m	ŋâaw	kwéɛn
	2SG	rúum-í	ŋôw-í	kwéɛn-í
	3SG	rúum	ŋôw	kwéɛn
	1PL.INCL	rwɔ̃m-kòɛn	ŋâK-kòɛn	kwéɛn-kòɛn
	1PL.EXCL	rwɔ̃m-kò	ŋâK-kò	kwéɛn-kò
	2PL	rwɔ̃m-èj	ŋâK-èj	kwéɛn-èj
	3PL	rwɔ̃m-(è)	ŋâK-(è)	kwéɛn-(è)

(54)		‘cane’	‘pound’	‘hold’
	1SG	dwáaaC	ʔáaal	káaaP
	2SG	dwééC-í	ʔóol-í	kééP-í
	3SG	dwééC	ʔóol	kééP
	1PL.INCL	dwáaaC-kòɛn	ʔáal-kòɛn	káaaP-kòɛn
	1PL.EXCL	dwáaaC-kò	ʔáal-kò	káaaP-kò
	2PL	dwáaaC-èj	ʔáaal-èj	káaaP-èj
	3PL	dwáaaC-(è)	ʔáaal-(è)	káaaP-(è)

(55)		‘blow’	‘hit’
	1SG	kwôoT̄	cjɛ̃m
	2SG	kwôooT̄-í	cɛ̃im-í
	3SG	kwôooT̄	cɛ̃im
	1PL.INCL	kwôT̄-kòɛn	cjɛ̃m-kòɛn
	1PL.EXCL	kwôT̄-kò	cjɛ̃m-kò
	2PL	kwôoT̄-èj	cjɛ̃m-èj
	3PL	kwôoT̄-(è)	cjɛ̃m-(è)

Within the alternating group two major classes and three minor classes can be distinguished based on the distribution of the alternating forms within paradigms. The major classes (1 and 2) reflect the behaviour of vowels in most of the paradigms. In class 1, the shorter vowels (whether short V or mid VV) occur in plural forms, and the longer vowels (whether mid VV or long VVV) occur in singular forms (56).

(56)		‘eat’	‘vomit’	‘cane’	‘search.by.partitioning’
	1SG	cáam	ŋâaw	dwáaaC	wéeer
	2SG	cáam-í	ŋôow-í	dwééεC-í	wééer-í
	3SG	cáam	ŋôow	dwééεC	wééer
	1PL.INCL	cám-kòn	ŋâK-kòn	dwáaC-kòn	wéer-kòn
	1PL.EXCL	cám-kò	ŋâK-kò	dwáaC-kò	wéer-kò
	2PL	cám-èj	ŋâK-èj	dwáaC-èj	wéer-èj
	3PL	cám-(è)	ŋâK-(è)	dwáaC-(è)	wéer-(è)

In class 2, the forms inflected for 1PL subject have shorter vowels than the rest of the forms (57).

(57)		‘finish’	‘bump’	‘blow’	‘pound’
	1SG	rwóom	tjéεT	kwôooT	?áaal
	2SG	rúum-í	tíiT-í	kwôooT-í	?óool-í
	3SG	rúum	tíiT	kwôooT	?óool
	1PL.INCL	rwóm-kòn	tjéT-kòn	kwôT-kòn	?áal-kòn
	1PL.EXCL	rwóm-kò	tjéT-kò	kwôT-kò	?áal-kò
	2PL	rwóom-èj	tjéεT-èj	kwôooT-èj	?áaal-èj
	3PL	rwóom-(è)	tjéεT-(è)	kwôooT-(è)	?áaal-(è)

What I refer to as the minor classes (3, 4 and 5) are the three lexical stems given in (58). The paradigms in (58) were elicited from two speakers. So far I have not come across other paradigms that show the same distribution of the alternating forms as those in (58). In class 3 (58a) forms inflected for SG and 1PL subjects have shorter vowels (VV) than the forms inflected for 2-3PL (VVV). In class 4 (58b) all forms except for 2-3SG have shorter vowels (V) and 2-3SG have longer vowels (VVV). In class 5 (58c) 1-2PL have shorter vowels (V) and the rest of the forms have longer vowels (VV).

(58)	a. class 3	b. class 4	c. class 5
	‘put into mouth’	‘hit’	‘count’
1SG	ɲjáam	cjɛ̃m	kwéɛn
2SG	ɲjòom-í	cɛ̃im-í	kwéɛn-í
3SG	ɲjòom	cɛ̃im	kwéɛn
1PL.INCL	ɲjáam-kòn	cjɛ̃m-kòn	kwén-kòn
1PL.EXCL	ɲjáam-kò	cjɛ̃m-kò	kwén-kò
2PL	ɲjáaam-èj	cjɛ̃m-èj	kwén-èj
3PL	ɲjáaam-(è)	cjɛ̃m-(è)	kwéɛn-(è)

In paradigms where there are no alternations in vowel length, vowels can be uniformly short (59), mid (60), or long (61).

(59)	‘punch\R’	‘dig’	‘steal’
1SG	pjém	téT	kwâl
2SG	pɛ̃m-í	tèT-í	kwâl-í
3SG	pɛ̃m	tèT	kwâl
1PL.INCL	pjém-kòn	téT-kòn	kwâl-kòn
1PL.EXCL	pjém-kò	téT-kò	kwâl-kò
2PL	pjém-èj	téT-èj	kwâl-èj
3PL	pjém-(è)	téT-(è)	kwâl-(è)

(60)	‘smell’	‘distribute’	‘work’
1SG	ɲwáaC	dáaw	lwóoj
2SG	ɲwɛ̃ɛC-í	dɛ̃ɛw-í	lwóoj-í
3SG	ɲwɛ̃ɛC	dɛ̃ɛw	lwóoj
1PL.INCL	ɲwáaC-kòn	dáaw-kòn	lwóoj-kòn
1PL.EXCL	ɲwáaC-kò	dáaw-kò	lwóoj-kò
2PL	ɲwáaC-èj	dáaw-èj	lwóoj-èj
3PL	ɲwáaC-(è)	dáaw-(è)	lwóoj-(è)

(61)		‘bring’	‘feed’	‘build’
	1SG	nóooŋ	mjǰǰǰǰT̄	táaaT̄
	2SG	nòooŋ-í	mìiiT̄-í	tǰǰǰǰT̄-í
	3SG	nòooŋ	mìiiT̄	tǰǰǰǰT̄
	1PL.INCL	nóooŋ-kòn	mjǰǰǰǰT̄-kòn	táaaT̄-kòn
	1PL.EXCL	nóooŋ-kò	mjǰǰǰǰT̄-kò	táaaT̄-kò
	2PL	nóooŋ-èj	mjǰǰǰǰT̄-èj	táaaT̄-èj
	3PL	nóooŋ-(è)	mjǰǰǰǰT̄-(è)	táaaT̄-(è)

Antipassive paradigms

Antipassive verbs can also be divided into two groups - those that exhibit vowel length alternations and those that do not.

Within the alternating group the shorter vowels are always found in 1PL forms. When these forms have short stem-internal vowels, the rest of the forms have mid vowels V~VV (62). With mid vowels in 1PL forms, the rest of the forms have long vowels VV~VVV (63).

(62)		‘count\AP’	‘smell\AP’	‘finish\AP’
	1SG	kwéen	ŋwǰǰǰC	rwǰǰom
	2SG	kwéen-í	ŋwǰǰǰC-í	rwǰǰom-í
	3SG	kwéen	ŋwǰǰǰC	rwǰǰom
	1PL.INCL	kwén-kòn	ŋwǰǰC-kòn	rwǰm-kòn
	1PL.EXCL	kwén-kò	ŋwǰǰC-kò	rwǰm-kò
	2PL	kwéen-èj	ŋwǰǰǰC-èj	rwǰǰom-èj
	3PL	kwéen	ŋwǰǰǰC	rwǰǰom

(63)		‘cane\AP’	‘send\AP (object)’	‘blow\AP’
	1SG	dwɛ̃ɛɛC	n̄ooP	k̄uuT
	2SG	dwɛ̃ɛɛC-í	n̄ooP-í	k̄uuT-í
	3SG	dwɛ̃ɛɛC	n̄ooP	k̄uuT
	1PL.INCL	dwɛ̃ɛɛC-k̄n	n̄ooP-k̄n	k̄uuT-k̄n
	1PL.EXCL	dwɛ̃ɛɛC-k̄	n̄ooP-k̄	k̄uuT-k̄
	2PL	dwáaaC-èj	n̄ooP-èj	kwóooT-èj
	3PL	dwɛ̃ɛɛC	n̄ooP	k̄uuT

In paradigms with no alternations, vowels can be uniformly short (64), mid (65), or long (66).

(64)		‘feed\AP’	‘dig\AP’	‘bite\AP\R’
	1SG	m̄íT	t̄èT	k̄èC
	2SG	m̄íT-í	t̄èT-í	k̄èC-í
	3SG	m̄íT	t̄èT	k̄èC
	1PL.INCL	m̄íT-k̄n	t̄èT-k̄n	k̄èC-k̄n
	1PL.EXCL	m̄íT-k̄	t̄èT-k̄	k̄èC-k̄
	2PL	m̄jéT-èj	t̄èT-èj	k̄èC-èj
	3PL	m̄íT	t̄èT	k̄èC

(65)		‘hit\AP’	‘burn\AP’	‘hate\AP’
	1SG	c̄im	cw̄èɛɛɛɛɛ	l̄ow
	2SG	c̄im-í	cw̄èɛɛɛɛɛ-í	l̄ow-í
	3SG	c̄im	cw̄èɛɛɛɛɛ	l̄ow
	1PL.INCL	c̄im-k̄n	cw̄èɛɛɛɛɛ-k̄n	l̄ow-k̄n
	1PL.EXCL	c̄im-k̄	cw̄èɛɛɛɛɛ-k̄	l̄ow-k̄
	2PL	c̄im-èj	cw̄èɛɛɛɛɛ-èj	l̄ow-èj
	3PL	c̄im	cw̄èɛɛɛɛɛ	l̄ow

(66)		‘punch\AP’	‘insult\AP’	‘bring\AP’
	1SG	píiim	léεεK	nóooη
	2SG	píiim-í	léεεK-í	nóooη-í
	3SG	píiim	léεεK	nóooη
	1PL.INCL	píiim-kòn	léεεK-kòn	nóooη-kòn
	1PL.EXCL	píiim-kò	léεεK-kò	nóooη-kò
	2PL	pjéεem-èj	léεεK-èj	nóooη-èj
	3PL	píiim	léεεK	nóooη

In the antipassive paradigms where more than one form is available for a given inflectional category (see section 5.4.1.2), stem vowels in the two alternative forms can differ in vowel length in addition to vowel/voice quality. One such paradigm (67a) has two antipassive forms for 1-2PL – one where vowel quality and length are the same as in 2-3SG antipassive forms, and another where the quality of vowel and its length corresponds to that of the 1PL in the transitive paradigms (67b).

(67)	a.	‘pound\AP’
	1SG	ʔɔ̃T
	2SG	ʔɔ̃T-í
	3SG	ʔɔ̃T
	1PL.INCL	ʔɔ̃T-kòn / ʔáaT-kòn
	1PL.EXCL	ʔɔ̃T-kò / ʔáaT-kò
	2PL	ʔɔ̃T-èj / ʔáaT-èj
	3PL	ʔɔ̃T
	b.	‘pound’
	1PL	ʔáal-kò(n)

We can see that with respect to vowel length alternations the antipassive verbs show a simpler behaviour than the transitive verbs. In the antipassive paradigms with vowel

length alternations it is always the 1PL forms that have shorter vowels. In transitive it could be 1PL forms; all singular forms and 1PL forms; all forms except 2-3SG forms; or all forms except 1-2PL forms. In the antipassive paradigms short vowels alternate with mid (V ~ VV), and mid vowels alternate with long (VV ~ VVV). In the transitive paradigms short vowels can also alternate with long, so that both V ~ VV and V ~ VVV are found.

5.4.2.2. Discussion

The purpose of this section is to propose an analysis of vowel length alternations in Thok Reel. I will aim to account for the distribution of the alternating forms within the paradigms and for the alternations that take place. I will begin by establishing the direction of the alternations. The fact that some paradigms exhibit vowel length alternations and some do not calls for an investigation into the phonological conditioning for vowel lengthening or its absence. I will show that in order to unveil the conditioning environments for the vowel length alternations we must take into account the basic values for voice quality and vowel quality. We will see that the phonological conditioning can indeed account for some cases, yet, in other cases no reliable heuristics can be given for the alternations or their absence. I will show that the situation is further complicated by the fact that the phonological conditioning differs depending on what vowel phoneme and what type of verb (transitive or antipassive) we are dealing with.

The first question that we need to address in relation to the vowel length alternations in Thok Reel is: what is the direction of the alternations? In other words, are we

dealing with vowel shortening or with vowel lengthening? Analyses of vowel length alternations in related languages Dinka and Shilluk (Andersen 1990; Remijsen and Gilley 2008; Reid 2009; Remijsen et al. 2009) suggest that the process is best analysed in terms of vowel lengthening. Some Western Nilotic languages, such as Pāri, have a two-way vowel length distinction which is thought to be a feature of the Proto-Western Nilotic. Andersen (1990) shows that the two-way vowel length distinction in Pāri maps onto the three-way vowel length distinction in Dinka. Andersen argues that the extra length distinction in Dinka has arisen through the loss of suffixation and the association of the mora of the lost suffix vowel with the stem vowel by compensatory lengthening. In Pāri, by contrast, the suffixation is largely preserved. Compensatory lengthening in Dinka is thought to have lengthened both short (V) and long (VV) vowels, turning them into long (VV) and overlong (VVV), respectively. Some V and VV did not lengthen, and thus a three-way vowel length distinction V ~ VV ~ VVV has developed. In synchronic terms we therefore distinguish between 1) short vowels (V) – those which were short prior to compensatory lengthening; 2) mid-length vowels (VV) – the original long vowels (VV) and those lengthened by compensatory lengthening from V to VV; and 3) long vowels (VVV) – vowels lengthened by compensatory lengthening from VV to VVV.

In my analysis of vowel length alternations in Thok Reel verbs I will assume that we are dealing with a process of vowel lengthening, just as in Dinka. A question that the reader might ask at this point is how a claim about vowel lengthening through the loss of suffixation can be justified when most of the inflectional categories in verb paradigms contain suffixes? Blench, Tula & Kato (2008) in their analysis of Tule, a Niger-Congo language spoken in Nigeria, explain a highly irregular noun morphology

expressed by prefixation, suffixation, infixation and their combinations by postulating a historical development of affix erosion and renewal (Blench, Tula and Kato 2008:6). The eroded affixes in Tule incorporated into the noun stems resulting in what Blench (p.c) terms ‘frozen morphology’. The new affixes were subsequently added to the stems that contain the frozen morphemes. The same process of affix incorporation, erosion and addition of the new affixation can be hypothesised to have taken place in Thok Reel.

Having established that the process of vowel alternations in Thok Reel is that of vowel lengthening, the next issue that needs to be addressed is which inflectional forms in verb paradigms can be considered as basic with respect to vowel length. In all paradigms where vowel length alternations take place the shorter vowels are found in plural forms, and most consistently, in forms inflected for 1PL subjects. Therefore, I propose to consider the forms inflected for 1PL as basic with respect to vowel length. A possible argument against this analysis is that the 1PL forms are the only forms where the suffixes begin with a consonant (-kə and -kən). The stem vowels in these forms are followed by a consonantal cluster (stem-final consonant plus the initial consonant of the suffix), unlike the stem vowels in the rest of the paradigmatic forms. Vowels followed by double consonants are known to have shorter durations cross-linguistically (see Maddieson (1985) for a cross-linguistic overview of vowel durations before single and geminated consonants). The shorter vowels in 1PL forms in Thok Reel could, therefore be due to a purely phonetic effect. This, however, is not the case as there are plenty of paradigms where all forms, including the 1PL forms, have mid or long stem vowels, see for example (68) below. The cross-linguistic evidence that vowels are consistently shorter before the consonantal clusters, however,

can serve as a diachronic explanation for why it is 1PL and not other forms that in some cases have failed to lengthen.

(68)	3SG	1PL	2PL	
VV	c̣im	c̣im-ḳð(n)	c̣im-èj	‘hit\AP’
	ŋwáaC	ŋwáaC-ḳð(n)	ŋwáaC-èj	‘burn’
VVV	léεεK	léεεK-ḳð(n)	léεεK-èj	‘insult\AP’
	ṃiiṬ	ṃjéεεṬ-ḳð(n)	ṃjéεεṬ-èj	‘feed’

Recall that in the discussion on voice and vowel quality alternations (section 5.4.1) I have shown that the forms inflected for 2-3SG subject contain the basic vowel values. In this section I have argued that with respect to vowel length, it is 1PL and not 2-3SG that are basic. This means that the basic (non-derived) values do not have to be traced to one given form in a paradigm. Instead, different forms within a paradigm can be said to be unmarked with respect to a given phonological value (thank you to Bert Remijsen for pointing this out to me). In Thok Reel verbs, therefore, the forms inflected for 2-3SG subject are basic with respect to vowel and voice quality, but the 1PL forms are basic with respect to vowel length.

The relevance of the basic values for vowel and voice quality to the discussion on vowel length is the following: referring to the basic vowel and voice quality values (as they appear in 2-3SG) in the analysis of vowel length alternations reveals certain regularities that remain obscured if the derived vowel and voice quality (for example, that in 1PL forms) is being considered. This point will become clear in the due course. The reared should keep in mind that in the following discussion I will be referring to the basic values for vowel and voice quality.

We are now almost set to proceed with the analysis of the phonological conditioning for vowel lengthening in Thok Reel verbs. Driving on the assumption that the 1PL forms are basic with respect to vowel length, three classes can be distinguished. One, where the basic vowel is short (69a), another where the basic vowel is mid (69b) and the third where the basic vowel is long (69c). I will deal with these classes in turn, starting with the short vowels.

(69)	a.	3SG	1PL	3PL	
	V	tèT	téT-kò(n)	téT-è	‘dig’
		ηóK	ηóK-kò(n)	ηóK	‘vomit\AP’
	V ~ VV	ηôw	ηâK-kò(n)	ηâK-(è)	‘vomit’
		ηwéεC	ηwéC-kò(n)	ηwéεC	‘smell\AP’
	V ~ VVV	kwôooT̄	kwôT̄-kò(n)	kwôooT̄-(è)	‘blow’
	b.	3SG	1PL	3PL	
	VV	dèew	dáaw-kò(n)	dáaw-è	‘distribute’
		cìim	cìim-kò(n)	cìim	‘hit\AP’
	VV ~ VVV	?óol	?áal-kò(n)	?áaal-è	‘pound’
		kúuuT̄	kúuT̄-kò(n)	kúuuT̄	‘blow\AP’
	c.	3SG	1PL	3PL	
	VVV	mìiiT̄	mjíεεT̄-kò(n)	mjíεεT̄-(è)	‘feed’
		léεεK	léεεK-kò(n)	léεεK	‘insult\AP’

As for the examples that will be given in the rest of this section: because the singular forms in most paradigms show a uniform behaviour with respect to vowel length, I will only include one of the singular forms, 3SG into the examples, since it contains the basic value for vowel and voice quality. Because in transitive paradigms the plural forms can vary with respect to vowel length I will include two plural forms in the examples – one inflected for 1PL subject and another inflected for 3PL subject. In the

antipassive paradigms all plural forms show a uniform behaviour with respect to vowel length, so only the 1PL forms will be given in the examples. Thus, the examples for transitive will consist of three forms per a paradigm which will come in the following order: 3SG, 1PL and 3PL; and the examples for antipassive will consist of two forms per a paradigm which will come in the following order: 3SG, 1PL.

Paradigms with short basic vowels

In (70) the basic vowel is /a/. No vowel lengthening takes place when these vowels are preceded by a complex onset (70a). Vowel lengthening occurs when these vowels are preceded by a simple onset (70b).

(70)	a. complex onset (TRANS)	b. simple onset (TRANS)
	‘steal’	‘eat’
3SG	kwâl	cáam
1PL	kwâl-kò(n)	cám-kò(n)
3PL	kwâl-(è)	cám-(è)

With vowels /e, ε/ the situation is the reverse: vowel lengthening takes place when the onset is complex (71a) and no vowel lengthening takes place when the onset is simple (71b).

(71)

	a. complex onset (TRANS)		b. simple onset (TRANS)	
	‘burn’	‘count’	‘know’	‘turn’
3SG	cwɛ̃ɛɲ	kwéén	ɲɛ̃C	wél
1PL	cwáɲ-kò(n)	kwén-kò(n)	ɲáC-kò(n)	wél-kò(n)
3PL	cwáɲ-(ɛ̃)	kwéén-(ɛ̃)	ɲáC-(ɛ̃)	wél-(ɛ̃)

In my data, the high back vowel /u/ always lengthens to mid (72a), whereas the vowel /i/ either stays short (72b), lengthens to mid (72c) or long (72d). Whether or not /i/ will lengthen cannot be predicted by examining the context in which it occurs.

(72)	TRANS	a. ‘finish’	b. ‘punch\R’	c. ‘bump’	d. ‘hit’
	3SG	rúum	pìim	túiT	cúim
	1PL	rwóm-kò(n)	pjém-kò(n)	tjéT-kò(n)	cjém-kò(n)
	3PL	rwóm-(ɛ̃)	pjém-(ɛ̃)	tjéT-(ɛ̃)	cjém-(ɛ̃)

Finally, no reliable heuristics can be given for vowel lengthening or its absence for the basic vowel /o/. Examples in (73) show that vowel lengthening can take place when the onset is simple (73a) or complex (73b-c), and equally, the stem vowel can fail to lengthen when preceded by a complex onset (73d). Moreover, in cases where the vowel lengthens, it can either lengthen to VV or to VVV: in (73a-b) the alternation is between V ~ VV, and in (73c) the alternation is between V ~ VVV. Thus, not only it is not possible to predict whether the vowel will or will not lengthen, it is also not possible to say whether vowel lengthening will result in mid or long vowel.

(73)	TRANS	a. ‘take’	b. ‘twist’	c. ‘blow’	d. ‘bury’
	3SG	nóoŋ	dwóol	kwôooT̄	kwón
	1PL	nán- <i>kò</i> (n)	dwól- <i>kò</i> (n)	kwôT̄- <i>kò</i> (n)	kwón- <i>kò</i> (n)
	3PL	nán-(<i>è</i>)	dwól-(<i>è</i>)	kwôooT̄-(<i>è</i>)	kwón-(<i>è</i>)

In all antipassive paradigms the vowel /a/ always occurs in syllables with Cw- onsets, and just as in transitive, the vowel does not lengthen (74).

(74)	AP	steal\AP’
	3SG	kwál
	1PL	kwál- <i>kò</i> (n)

Vowels /ɔ, ε, e/ lengthen when they occur in syllables with complex onset (75a), and no lengthening takes place when they occur in syllables with simple onset (75b). Note that the same behaviour was observed for the vowels /ε, e/ in transitive paradigms, but no data with the basic /ɔ/ vowel is available for transitive.

(75)	AP	a. complex onset			b. simple onset		
		‘put.into. mouth\AP’	‘smell\AP’	‘count\AP’	‘vomit\AP’	‘kill\AP’	‘dig\AP’
3SG		ŋjðom	ŋwɛ̃ɛC	kwɛ̃en	ŋɔ̃K	nɛ̃w	tɛ̃T
1PL		ŋjðm- <i>kò</i> (n)	ŋwɛ̃C- <i>kò</i> (n)	kwɛ̃n- <i>kò</i> (n)	ŋɔ̃K- <i>kò</i> (n)	nɛ̃w- <i>kò</i> (n)	tɛ̃T- <i>kò</i> (n)

The high short vowel /i/ is invariably short in the antipassive paradigms (76).

(76)	AP	‘feed\AP’	‘punch\AP\R’
	3SG	míT	pòm
	1PL	míT-kò(n)	pòm-kò(n)

As for the distribution of the forms that exhibit vowel lengthening in the transitive paradigms, it is possible to predict in which of the paradigms the forms inflected for plural subject will be shorter than the forms inflected for the singular subject.

Examples in (77) show that vowel length alternations correlate with the alternations in stem-final consonant. Vowel lengthening occurs in forms inflected for singular but not for plural subject when the singular stems end in a glide and the plural stems end in a stop. One possible way to analyse vowel length alternations in these paradigms is to consider the glide in stem-final position to be the conditioning context for vowel lengthening. Support for this hypothesis comes from the example in (77c). There, the basic vowel /e/ is mid-length in singular forms despite our earlier observation that this vowel does not lengthen in syllables with simple onsets (see (71)). Since it lengthens in (77c) we can infer that the nature of the stem-final consonant should also be taken into account when explaining vowel length alternations. In fact, there are no transitive stems with short vowels that end in a glide.

(77)	TRANS	a.	b.	c.
		‘bite’	‘hate’	‘kill’
	3SG	kâaj	lów	néew
	1PL	kâC-kò(n)	lóK-kò(n)	náK-kò(n)
	3PL	kâC-(è)	lóK-(è)	náK-(è)

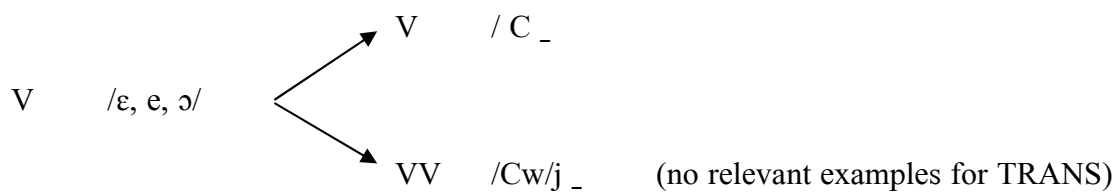
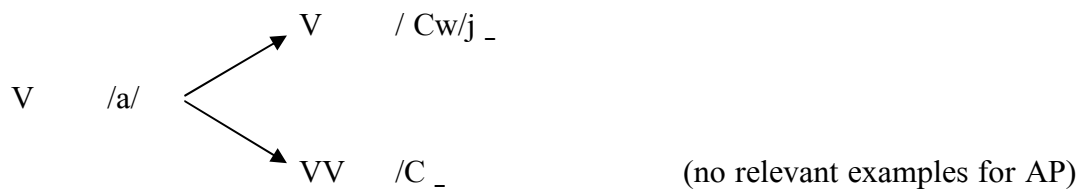
With the antipassive verbs, the stem-final consonants do not alternate within paradigms, but the glides do occur in stem-final position (78). However, there is no evidence for vowel lengthening in such forms.

- (78) AP 'kill\AP'
3SG nɛ̃w
1PL nɛ̃w-kò(n)
3PL nɛ̃w

The two conditions for vowel lengthening and its absence identified in the above discussion are given in (79). The onset condition is represented in (79a) and the stem-final consonant condition is represented in (79b). The onset condition is applicable in the transitive and the antipassive paradigms. The stem-final consonant condition is only applicable in the transitive paradigms. The stem-final consonant condition tells us that a basic short stem vowel becomes mid when followed by one of the glides. What is remarkable about the onset condition is that the structural nature of the onset (simple or complex) triggers the opposite processes for the different vowel phonemes. Presence of a complex onset correlates with vowel lengthening for /ɛ, e/ in transitive and antipassive and also /ɔ/ in antipassive, but not for /a/; and presence of a simple onset correlates with vowel lengthening for /a/ in transitive but not for /ɛ, e/ in transitive and antipassive and not for /ɔ/ in antipassive.

(79)

a. *Onset condition*



b. *Stem-final consonant condition (TRANS only)*

V → VV / _ w/j

We saw that in order to explain vowel length alternations in verb paradigms the analysis must take into account vowel and voice quality of the basic vowel; the structural characteristics of the onset (whether simple or complex); the nature of the stem-final consonant (whether a stop or a glide); and the grammatical information (transitive or antipassive). It is not the most elegant analysis, as it does not give us a satisfactory explanation for some of the alternations (e.g. /o/), and it requires postulating conflicting conditions for different vowel phonemes, but it also appears to be the optimal analysis. For example, another way in which we could try to account for the alternations is to consider the correlations between vowel length alternations and the nature of the derived voice and vowel quality values of the vowels. Consider examples in (80) where some of the paradigms with the basic /e, ε/ are grouped

together with the paradigms with the basic /a/ vowel by virtue of having a derived /a/ (in forms other than 3SG).

(80) TRANS

	simple onset		complex onset	
	‘know’	‘eat’	‘steal’	‘burn’
3SG	ŋɛ̃C	cáam	kwâl	cwɛ̃ɛɲ
1PL	ŋáC-kò(n)	cám-kò(n)	kwâl-kò(n)	cwáɲ-kò(n)
3PL	ŋáC-(ɛ̃)	cám-(ɛ̃)	kwâl-(ɛ̃)	cwáɲ-(ɛ̃)

Looking at the data this way obscures the onset condition since both complex and simple onsets now appear in paradigms that exhibit vowel length alternations and those that do not. For this reason, I will continue the description of the vowel length alternations by referring to the vowel and voice quality of the basic vowels.

Paradigms with mid basic vowels

In paradigms with mid basic vowels it is not possible to predict if the vowel length alternations will take place by examining the context in which the vowels occur.

Consider examples in (81) and (82). Vowels lengthen in (81a) and (82a) in transitive and antipassive, respectively, but fail to lengthen in similar contexts in (81b) and (82b).

(81)	TRANS	a.	b.
		‘cane’	‘smell’
	3SG	dwɛ̃ɛɛC	ɲwɛ̃ɛC
	1PL	dwɛ̃ɛC-kò(n)	ɲwɛ̃ɛC-kò(n)
	3PL	dwɛ̃ɛC-(è)	ɲwɛ̃ɛC-(è)
(82)	AP	a.	b.
		‘hold\AP’	‘build\AP’
	3SG	kɛ̃ɛɛP	tɛ̃ɛT
	1PL	kɛ̃ɛP-kò(n)	tɛ̃ɛT-kò(n)

It must be noted that whereas in synchronic terms the stems in (81) and (82) have mid basic vowels, diachronically there could be a difference between them. In the discussion on paradigms with short basic vowels we saw that in a given paradigm all forms except 1PL can appear with mid stem vowels which were argued to have lengthened from short. In principle, there could also be paradigms where all forms including 1PL have undergone vowel lengthening. We would expect that the conditions given in relation to vowel lengthening in (79) would be satisfied in such paradigms.

Consider examples for transitive paradigms in (83). The basic vowel /ɛ̃/ in (83a) occurs in a syllable with complex onset – the conditioning context in which we expect this phoneme to lengthen (see (79a)). In (83b) there is a glide in stem-final position in all paradigmatic forms, hence, we can assume that the diachronically short vowels have lengthened to mid throughout these paradigms.

(83) TRANS

	a. Onset condition	b. Stem-final consonant condition	
	‘smell’	‘distribute’	‘work’
3SG	ɲwɛ̃ɛC	dɛ̃ɛw	lwóoj
1PL	ɲwáaC-kò(n)	dáaw-kò(n)	lwóoj-kò(n)
3PL	ɲwáaC-(è)	dáaw-(è)	lwóoj-(è)

There are also paradigms, mostly in the antipassive, where the vowel is mid-length throughout the paradigm, but the conditions for vowel lengthening given in (79) are not met. In (84) the basic /ɛ/ vowel occurs in the syllable with a simple onset (cf. (83b)). These paradigms can be either the counter-examples to the proposed analysis, or the original mid (VV) vowels that have failed to lengthen. More data will help to clarify this point.

(84)	‘milk’	‘build\AP’
3SG	ɲɛ̃ɛC	tɛ̃ɛT̄
1PL	ɲáaC-kò(n)	tɛ̃ɛT̄-kò(n)
3PL	ɲáaC-(è)	tɛ̃ɛT̄

Whilst the diachronic perspective is certainly the right way to go about explaining the apparent irregularities, synchronically we have mid-length vowels that either lengthen or fail to lengthen. These are the forms that a learner of the language has to master on a case-by-case basis (thank you to the participants of the LEL postgraduate conference at the University of Edinburgh for this insight).

Paradigms with long basic vowels

Finally, there are also paradigms in which all vowels are uniformly long (85). Recall that the long vowels are thought to be an innovation in some of the Western Nilotic languages.

(85)

	TRANS			AP	
	‘feed’	‘separate’	‘like’	‘like\AP’	‘bring\AP’
3SG	m̄iiṽ	d̄ɛɛw	ɲjáaar	ɲj̄ɛer	n̄ooŋ
1PL	m̄j̄ɛɛṽ-k̄ɔ̄(n)	d̄áaaw-k̄ɔ̄(n)	ɲjáaar-k̄ɔ̄(n)	ɲj̄ɛer-k̄ɔ̄(n)	n̄ooŋ-k̄ɔ̄(n)
3PL	m̄j̄ɛɛṽ-(è)	d̄áaaw-(è)	ɲjáaar-(è)	ɲj̄ɛer	n̄ooŋ

In Thok Reel, long vowels can be found in all forms within a verbal paradigm. For example, in (86) the forms in the paradigms differ in tone. In addition, the 1PL forms differ in terms of vowel length. In (86a) the vowels in 1PL are shorter than the vowels in the rest of the forms. In (86b) 1PL forms have the same vowel length as in the rest of the forms within their paradigm. Whereas I have not conducted an in-depth analysis of other paradigmatic forms such as the infinitive and the passive, there is evidence to suggest that at least in the transitive paradigms the infinitive and the passive forms never have shorter vowels than the finite transitive forms inflected for 1PL, thus all forms in a given paradigm can have long vowels (VVV).

(86)	a.	b.
TRANS	‘send (message)’	‘send (object)’
3SG	n̂ooP	n̂ooP
1PL	n̂ooP-k̂(n)	n̂ooP-k̂(n)
3PL	n̂ooP-(è)	n̂ooP-(è)
AP	‘send\AP (object)’	‘send\AP (message)’
3SG	n̂ooP	n̂ooP
1PL	n̂ooP-k̂(n)	n̂ooP-k̂(n)

Again, we can infer a diachronic change whereby the vowels in all paradigmatic forms have lengthened to long. With the transitive paradigms it is also unclear whether these verbs originally had V or VV, as we have seen that both can lengthen to VVV.

5.4.2.3. Comparative perspective and final remarks

The three-way vowel length distinction found in some Western Nilotic languages, including Thok Reel, is a typologically unusual phenomenon which might be restricted to these languages. The languages with a two-way vowel length distinction, on the other hand, are very common. Remijsen & Gilley (2008), in their analysis of vowel length in Dinka, show that the third level of vowel length (VVV) is best thought of as strictly morphological. In Dinka, morphologically simple forms do not appear with long vowels, only with short or mid vowels. The authors distinguish between lexically short stems CVC and lexically long stems CVVC and between short and long grades of these stems. The short grade corresponds to the lexical length of the stem vowel (whether V or VV) and the long grade correspond to the morphological length of the stem vowel (either VV or VVV). A verb stem in Dinka

can be either lexically short or lexically long and each stem comes in two grades – short and long. There is a neutralisation between the long grade of the short stem and the short grade of the long stem – both contain a mid-length vowel (VV). Similarly, in Shilluk a distinction is made between short and long verb stems and short and long grades of these stems (Remijsen et al. 2009). However, unlike in Dinka, both short and long stems in Shilluk lengthen to VVV, hence the neutralisation occurs between the long grades of the short and the long stems. In addition, in Shilluk but not in Dinka, some short stems remain phonologically short and others have long and short grades.

Importantly, in both languages long vowels can be synchronically traced to the shorter vowels. In Thok Reel, by contrast, all three levels of vowel length can be considered synchronically as lexical. Therefore, I distinguish between lexically short, lexically mid and lexically long stems. In Remijsen and Gilley’s terminology, therefore, lexically short and lexically mid stems can have short and long grades, and lexically long stem has only one grade. In Thok Reel, the short and the mid stems can also remain phonologically short. Table 6 summarises the patterns of vowel length alternations in Thok Reel verbs and compares them to the vowel length alternations in Dinka and Shilluk verbs.

Table 6. Comparative summary of vowel length verb classes in Thok Reel, Dinka and Shilluk.

	Thok Reel	Dinka	Shilluk
Short fixed	V		V
Short with grade	V ~ VV V ~ VVV	V ~ VV	V ~ VVV
Mid fixed	VV		
Mid with grade	VV ~ VVV	VV ~ VVV	VV ~ VVV
Long fixed	VVV		

We can see that there is more complexity in Thok Reel with respect to vowel length alternations than in Dinka and Shilluk. The diachronic development of the vowel length alternations in Thok Reel certainly deserves special attention. One of the suggestions for future research in this area is a comparative investigation based on the evidence from a larger Thok Reel data set and on data from other related languages.

The data presented in this section shows that there is a lot of idiosyncrasy with respect to vowel length alternations in verb stems, especially in transitive verbs. One of the lines for future research is to investigate whether the paradigms for other lexical verbs fit into the patterns described here, in particular, into some of the minor patterns. I also hope to conduct a quantitative study by recording selected data with a representative number of speakers (between 10-20).

6. TONE

6.1. Introduction

In this section I will give a descriptive analysis of tone in Thok Reel. In section 6.2 I will present the inventory which consists of the three tonemes: two level tones High (H) and Low (L) and a contour tone High-Low (HL). In section 6.3 I will comment on the nature of the task of tone analysis in Thok Reel and describe the materials used in the analysis. In section 6.4 I will give a description of phonetics of tone in Thok Reel. In this section I will account for the phonetic modifications of pitch patterns. I will show that there is a constraint on the scope of variation in the realisation of the pitch patterns. This constraint is the alignment of what I call a *pitch target* within a syllable. I will give heuristics that help to identify the tonemes in various contexts and I will show that some contextual effects lead to neutralisation of the tonal distinctions.

In the second part of the discussion, section 6.5, I will give a description of the phonological modifications. These involve two sandhi processes: Dissimilatory Lowering and Contour Simplification, and one contextual modification: Low Deletion. At the end of the section I will discuss the status of the contour tone based on the evidence from the phonological modifications that it undergoes.

In the last part of the discussion, section 6.6, I will give a descriptive account of the phonological processes in sentences. The discussion will be concerned with the direction and interaction of the tonal processes. In 6.6.1 I will show that the two speakers whose data I have considered exhibit a difference in the ordering of the processes discussed in section 6.5. In 6.6.2 I will describe the variation in the onset

and direction of sandhi processes in sentences with different finite verbs – lexical (transitive and antipassive) and auxiliary. On the basis of the evidence discussed in this section I will hypothesise that in addition to being a purely phonological phenomenon, tone sandhi in Thok Reel is used by syntax to signal syntactic relations, and that syntax governs the order of the application and the direction of the sandhi processes. In 6.6.3 I will show that we can avoid postulating a direct syntax-phonology connection by analysing the processes discussed in 6.6.2 in the light of the Precompilation theory (Hayes 1990). The discussion in this section will also have an impact on the analysis of the onset and direction of sandhi processes in sentences. In 6.6.4 I will discuss the ordering of Dissimilatory Lowering and Contour Simplification processes. Finally, in 6.6.5 I will give a description of rule ordering and tonal neutralisation in sentences with the past tense auxiliary *cĕ*. On the bases of the tonal alternations in these sentences I will postulate that two processes take place at the surface level – an optional Dissimilatory Lowering and a process of tone Replacement.

6.2. Inventory

There are three tonemes in Thok Reel High (H), Low (L) and High-Low (HL). Near-minimal pairs for tone are given in (87). In Thok Reel every syllable carries a tone, except perhaps the word-initial a- and ma- syllables (see (5) in section 3.3) which I have not studied in detail. Tone is used to distinguish lexical items (see ‘night\SG’ and ‘dung\SG’) and to signal morphological distinctions (all other examples in 87).

(87)	H		L
	ców	‘husband\SG\NOM’	còw ‘husband\PL\NOM’
	nòooŋ	‘bring\AP\3SG’	nòooŋ ‘bring\3SG’
	H		HL
	wêeer	‘night\SG\NOM’	wêeer ‘dung\SG\NOM’
	têeeT	‘hand\PL\NOM’	têeeT ‘hand\PL\ACC’
	kwál	‘steal\3SG’	kwâl ‘steal\AP\3SG’
	L		HL
	tèeeT	‘hand\SG\NOM’	têeeT ‘hand\SG\ACC’
	dêëew	‘separate\3SG’	dêew ‘separate\AP\3SG’
	bùul	‘roast\AP\3SG’	bûul ‘roast\3SG’

6.3. Analysis of tone in Thok Reel

Analysis of tone in Thok Reel was not a trivial task, and my understanding of the phonological processes in particular has lagged behind my understanding of other aspects of (morpho)phonology (e.g. vowel alternations) for a considerable period of time. The reason is that when interpreting the surface patterns one must consider all of the following possibilities: sandhi modifications, tonal allophony and morphological inflection. Consider the surface realisations of tone on the noun gwɔ̀p ‘skin\SG’ in (88). In (88a) the surface tone is [HL], in (88b) it is [H], in (88c) it is [L], and in (88d) it is [H].

- (88) a. [gwɔ̀p] [HL]
 skin\SG\NOM
skin
- b. [gwɔ̀b è-lɛ̀ŋ] [H.L.HL]
 skin\SG\NOM DECL-good\SG\PRED
The skin is good.
- c. [è-njâaar gwɔ̀p] [L.H.L]
 DECL-like\1SG skin\SG\ACC
I like the skin.
- d. [è-cɛ̀ gwɔ̀p njâaar] [L.H.H.HL]
 DECL-PST\1SG skin\SG\ACC like\TRANS
I have liked the skin.

Because I did not know in advance in which cases to attribute the surface patterns to the effects of tone sandhi, tonal allophony or inflection, analysis of tone in Thok Reel was a particularly laborious task. For example, one of the possible inferences that we can make by looking at the surface realisations in (88) is that these different tonal

patterns signal inflectional categories: the form in (88a) could be a pattern used exclusively for nouns in citation form; the form in (88b) could be an inflectional category which signals that the noun is a grammatical subject; the form in (88c), then, could be the inflectional category which signals that the noun is a grammatical object as it appears after a finite lexical verb; and the form in (88d) could be the inflectional category which signals that the noun is a grammatical object as it appears after an auxiliary and before the infinitive. Another possibility is that the tone on the noun changes as a result of the phonological sandhi processes, in which case we would want to find out why the surface tone on the noun differs in seemingly identical contexts in (88c-d) where the preceding tone is [H]. This, in turn, can mean that the underlying tone on the preceding syllable is different in (88c) and (88d). In short, when investigating a system where tone serves both lexical and morphological functions and the tonemes are subject to phonological modifications, the possibilities of explaining tonal alternations multiply.

In the analysis of tone I have used a speech analysis software package Praat (Boersma & Weenink 2005) which allowed me to supplement perceptual impressions with visual inspections of the fundamental frequency traces.

6.3.1. Materials used in analysis

The analysis presented in this chapter was initially based on the investigation into the behaviour of tone in nouns. Determining tone in nouns is easier than in verbs as nouns can be substituted into a variety of contexts. By contrast, the position of verbs in a sentence is relatively fixed. Understanding the behaviour of tone in nouns, in turn,

helps to determine tone in verbs. We will see that tone sandhi helps to determine the underlying tone (whether lexical or morphological) even in cases where the distinction between the tonemes has been neutralised. For example, if verbs V1 and V2 have the same surface tone, but the tone on noun N following these verbs has different surface realisations, we could infer that these verbs have different underlying tone.

In my analysis I have used a wide range of contexts that served as frames in which the nouns were substituted. Out of considerations for semantic acceptability I have used the verb ‘like’ to elicit all nouns in object position. In addition, most of the nouns were elicited in object position in clauses with various finite lexical verbs during the elicitation sessions on verbal paradigms. In this way, most nouns in my data appeared in object position with at least two verbs: with the verb ‘like’ and with another verb. Nouns were elicited in phrase-initial, phrase-final and phrase-medial contexts. The phrase-initial contexts consisted of: citation form (89) and subject of a predicative clause (90). The phrase-final contexts were: object position in a simple declarative clause after a finite lexical verb inflected for 1SG subject (91a), and for 2SG subject (91b). The phrase-medial contexts were: object position in a simple declarative clause after a finite lexical verb inflected for 2SG subject and followed by a modifier (91c), and object position after the auxiliary and before the infinitive (92).

(89) *ʃáT̄*
 tree\SG\NOM
 tree

(90) *ʃáT̄* *è-l̄ɛŋ*
 tree\SG\NOM DECL-good\SG\PRED
 The tree is good.

- (91) a. è-ŋjáaar jǎT̄
DECL-like\1SG tree\SG\ACC
I like the tree.
- b. è-ŋjáaar-í jǎT̄
DECL-like-2SG tree\SG\ACC
You like the tree.
- c. è-ŋjáaar-í jǎT̄ mé lé-lêŋ
DECL-like-2SG tree\SG\ACC SG RED-good\SG\ATTR
You like a good tree.
- (92) è-cé jǎT̄ ŋjáaar
DECL-PST\1SG tree\SG\ACC like\TRANS
I have liked the tree.

The verb and noun data sets considered here were described in section 2.3. All nouns were monosyllabic.

The contexts given in (89-92) were elicited from a Luac speaker. The verbal paradigms were elicited mainly from a Jilek speaker. In addition, selected examples were recorded with both speakers. It must, however, be noted that the generalisations made here were not subject to a quantitative examination (that is, my analysis is based almost entirely on the data from the two native speakers). This is particularly relevant to any reported differences between the two speakers which could be attributed to the differences between idiolects or dialects. Whenever possible I have cross-referenced the data from the two speakers with the data from other Luac and Jilek speakers (recorded during my first data collection trip). On the bases of these examinations I am inclined to think that the differences described here are the differences between the dialects, however, the relevant data from the multiple speakers was so scarce that

for the time being I have decided to attribute these differences to the differences between the idiolects.

6.4. Phonetics of tone

A striking characteristic of the phonetic realisation of the tonemes in Thok Reel is that the frequency range in which the highs and lows are realised is somewhat narrow.

This is especially true for the speakers from the Luac section and less so for the speakers from the Jilek and Kuek sections (here I am giving the observations for all of the speakers with whom I have worked). For example, the averaged frequencies across a H toned and a L toned syllables in a minimal pair *ców* ‘husband\SG\NOM’ ~ *còw* ‘husband\PL\NOM’ uttered in isolation by a male Luac speaker are 115 Hz and 106 Hz, respectively. This narrow frequency range between the contrastive pitch levels is also observed in the neighbouring Dinka dialects Agar and Thong Apak (Bert Remijsen p.c.). Speakers of the Dinka dialects where the highs and lows have a relatively wide frequency distribution, when describing the characteristics of, for example, Agar dialect, say that they speak ‘in the middle’.

The relatively narrow frequency range in which the contrastive pitch levels are realised can easily lead to an overlap between the tones in certain contexts, rendering them perceptually indistinguishable for the (non-native) hearer. Part of the discussion on the phonetics of tone in Thok Reel, therefore, includes a description of the acoustic correlates that may be employed to differentiate the tonemes. Under discussion will be the acoustic correlate of pitch – fundamental frequency (f_0). The description will focus on the patterns of f_0 alignment. Alignment refers to the way in which pitch movements map onto the segmental string (Ladd 2008:169). To give an example, a falling tone A and a falling tone B can be said to differ in alignment when the onsets of these falls begin at different timing points relative to the segmental string. This is exemplified in Figure 17 by the data from another Western Nilotic language, Shilluk.

In this language two phonological falls (Late (High) Fall and High Fall) differ solely in terms of alignment. The onset of the target vocalic portions is marked by vertical lines in Figure 17. The fall in f₀ is aligned late into the vocalic portion in panel A and early in panel B. Cross-linguistically, the differences in the alignment of pitch movements are perceptually significant (Ladd 2008).

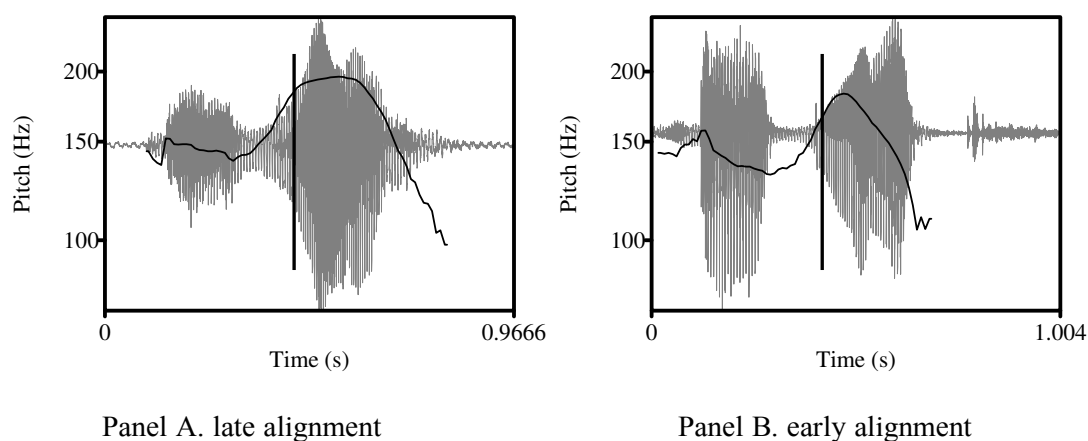


Figure 17. Shilluk examples of late alignment of fall in [dàa gwóóò] ‘this dog (next to the speaker)’ in panel A, and early alignment of fall in [dàa gwóóòk] ‘these dogs’ in panel B. The vertical lines mark the onset of glide-vowel sequence. Data from Reid 2009.

Figure 18 below shows f₀ tracks for our earlier Thok Reel words ców ‘husband\SG\NOM’ vs. còw ‘husband\PL\NOM’ uttered in isolation. We can see that the f₀ tracks for H (solid line) and L (dotted line) set off at about the same frequency level. Both tracks show a small fall in f₀ at the onset of the vocalic portion (=onset of the f₀ tracks). This can be attributed to the influence of the voiceless stop at the onset. Voiceless stops in Thok Reel tend to have a raising effect on f₀ (and also in Shilluk, see Reid 2009). With H, this small fall levels off at around one-third into the vocalic portion. From that point, f₀ fluctuates at a high level until the end of voicing (=end of f₀ track). With L, the fall sets off from about the same level as that for H but it continues until the end of the vocalic portion (=end of f₀ track). The difference

in f0 height for H and L is most salient at the offset of the vocalic portion which roughly corresponds to the glide portion. For H, f0 is at the high end of the speaker's range, and for L, f0 is at the low end of the speaker's range. The realisation of f0 in the minimal pair for tone in Figure 18 suggests that in cases where there is a considerable frequency overlap between the contrastive pitch levels, the difference in f0 alignment insures that the two tonemes are identified correctly.

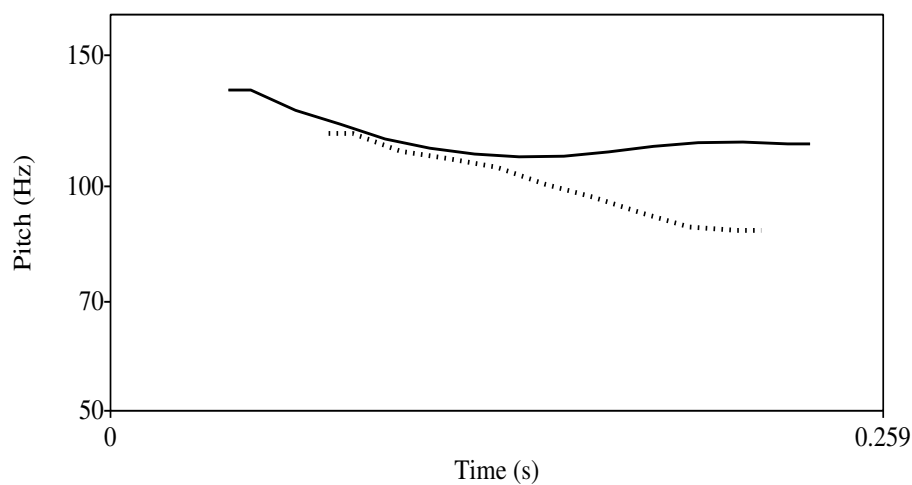


Figure 18. F0 alignment in a minimal pair for tone: ców 'husband\SG\NOM' vs. còw 'husband\PL\NOM' uttered in isolation. H (solid line) and L (dotted line).

Despite of the alignment differences evident from Figure 18, I personally find it difficult to differentiate between the two words when they occur in isolation. We will see in section 6.5 that in such cases the addition of the context helps to disambiguate the two tonemes.

The differences in pitch levels for H tone in syllables with breathy and modal vowels can, on the other hand, lure us into thinking that we are dealing with two different tones H and L. In such cases f0 alignment can also help us to determine that we are dealing with the same tone. A H tone in syllables with breathy vowels is perceptually

lower in pitch than a H tone in syllables with modal vowels. Figure 19 shows f₀ tracks in a minimal pair for voice quality cáaar ‘to.aim’ (dotted line) and c̣aar ‘black’ (solid line). Both words are H toned. We can see from Figure 19 that the f₀ patterns are identical except for the height of f₀. In the syllable with the modal vowel f₀ is somewhat higher than in the syllable with the breathy vowel.

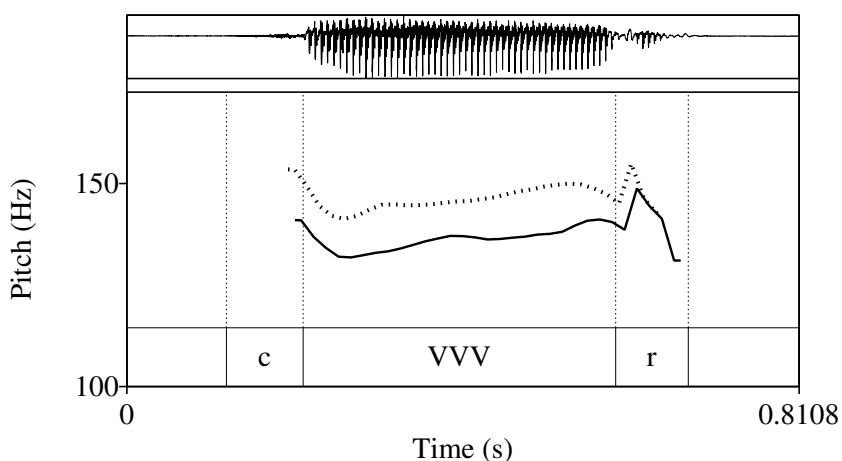


Figure 19. H tone in a minimal pair for voice quality uttered in isolation. Dotted line cáaar ‘to.aim’; solid line c̣aar ‘black’.

A H tone in syllables with breathy vowels is saliently different from a H tone in syllables with modal vowels, but it is also perceptually different from a L tone which is realised with a falling trajectory in this context (cf. Figure 18).

When L and HL toned monosyllabic words are uttered in isolation it is notoriously difficult to tell them apart. This is especially true of the syllables where the vowel is flanked by oral stops. Consider the Figure 20 where HL (broken line) and L (dotted line) are realised with a falling trajectory that is identical. Moreover, there is almost no difference between the frequency levels: f₀ tracks set off from about the same frequency level and end at about the same frequency level. This could be due to the

fact that HL occurs in a syllable with a breathy vowel t̚uuT, and L in a syllable with a modal vowel d̚iiT (cf. the realisation of H in Figure 19). Again, in such cases the addition of context helps us to disambiguate the two tonemes (see sections 6.5 and 6.6).

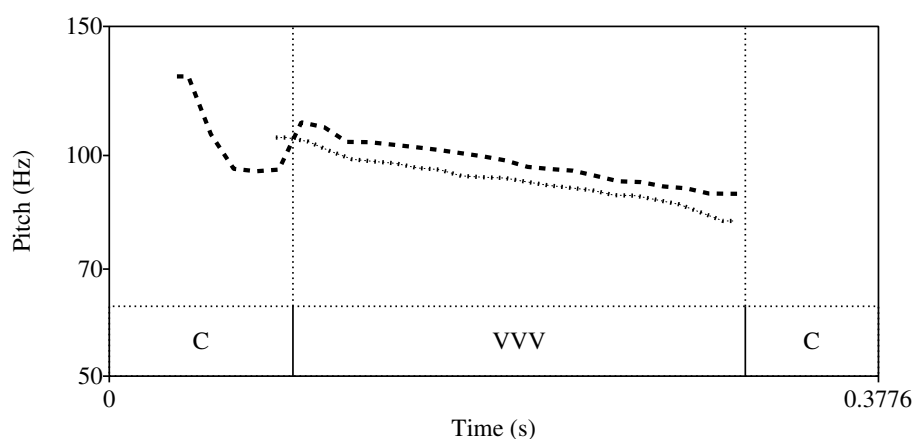


Figure 20. F0 alignment for HL (broken line) and L (dotted line) in monosyllabic words d̚iiT ‘bird\PL\NOM’ and t̚uuT ‘male.animal\SG\NOM’ uttered in isolation.

Table 7 gives a summary of the surface patterns of tone in Thok Reel. We can distinguish seven surface patterns: high level, rise, rise-then-fall, mid level, low level, early fall and late fall. These surface patterns are the phonetic realisations of the three tonemes H, L and HL in different contexts. In particular, the phonological H tone can be realised as high level, rise, mid level and low level; the phonological L can be realised as mid/low level, or as an early fall; and the phonological HL can be realised as an early fall, rise-then-fall and as a late fall.

Table 7. Surface patterns of tone.

Context	/H/	/L/	/HL/
ISOL	high level	early fall	early fall
	mid/low level		late fall
# _ T	high level	mid/low level	-
	mid/low level		
L _ #	rise (then high level)	early fall	late fall
			rise-then-fall
L _ T	rise (then high level)	mid/low level	-
H _ #	mid level	early fall*	-
H _ T	mid level	early fall*	-
		mid/low level	
H.H _ #	low level	early fall	-
H.H _ T	low level	early fall	-
		mid/low level	

ISOL = isolation; T = any tonal context; # = utterance boundary

* excluding cĕ _ context (see section 6.6.5)

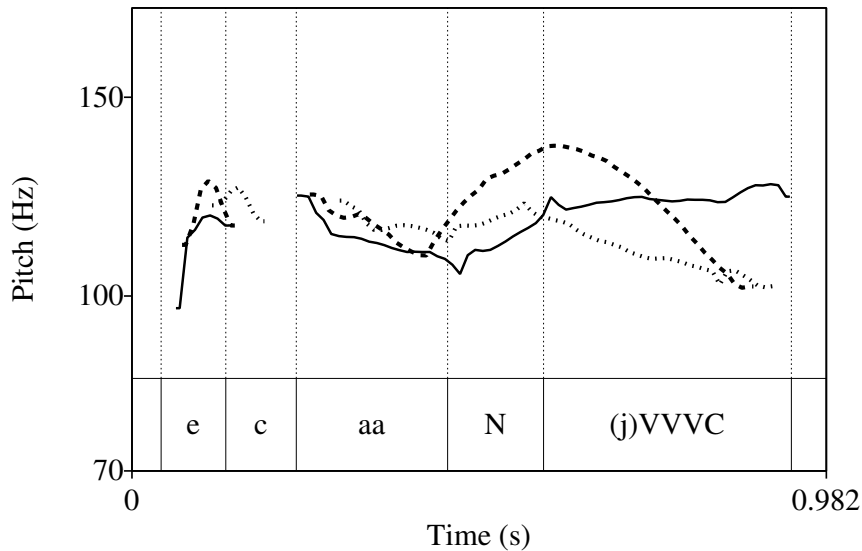
Because of the narrow frequency range within which the highs and the lows are realised, syllable-internal and contextual effects can easily lead to a neutralisation of the tonal distinctions. The shaded cells in Table 7 signal the contexts in which the distinctions between the f0 alignment for the three tonemes are neutralised. For example, we saw earlier that the distinctions between the f0 alignment for HL and L

can be neutralised in ISOL context. The description of the other neutralisations in Table 7 will be given later on in this section.

The availability of more than one pitch pattern (splits cells in Table 7) in a given context can be due to a number of reasons. We saw earlier that the two pitch patterns for a phonological H in ISOL are due to the differences in voice quality of the stem vowels. Similarly, we saw that f₀ alignment for HL in syllables with breathy vowels can be indistinguishable from the f₀ alignment for L in syllables with modal vowels. The two pitch patterns for HL in ISOL and L_# contexts are also due to syllable structure. This issue will be discussed in section 6.4.1. Finally, the phonological HL does not occur in the rest of the contexts in Table 7 as in these contexts it is subject to sandhi processes and a context-induced phonological modification (see section 6.5).

The difference between the three tonemes is most salient in phrase-final context after a L tone. Figure 21, below, shows that H (solid line) in this context is realised with a somewhat rising f₀ trajectory. The rise starts from the level of the preceding L tone on càa. The onset of the rise coincides with the onset of the syllable – the portion marked on the annotation tier as N (for nasal). The rise is fairly steep during this portion and it levels off at the beginning of the vowel (marked as (j)VVV on the annotation tier). From that point onwards f₀ is level notwithstanding a small rise at the end of the syllable which terminates in a [+sonorant] coda. HL (broken line) and L (dotted line) are both realised with a rising-then-falling f₀ trajectory. The rise in both cases is aligned at the onset of the nasal stop; f₀ reaches the highest point at the onset of the glide-vowel portion; and the fall continues until the offset of voicing (end of syllable). What differentiates the two tonemes is the height to which f₀ rises and from which it

subsequently falls. With L, the rise from the low target of the preceding syllable is rather small. The fall, in turn, starts from a relatively low position. With HL, f0 rises to the top of the speaker's range, hence the fall sets off from a relatively high position.



H (solid line)	è-càa DECL-PST\PASS <i>It has been brought.</i>	nóooŋ bring\TRANS
L (dotted line)	è-càa DECL-PST\PASS <i>It has been put into the mouth.</i>	ŋjàaam put.in.mouth\TRANS
HL (broken line)	è-càa DECL-PST\PASS <i>It has been liked.</i>	ŋjàaar like\TRANS

Figure 21. F0 alignment for the three tonemes phrase-finally following a L tone.

The small rise at the beginning of the L toned syllable is not perceptually salient, hence it is excluded from the description of the pitch patterns for this toneme. This small rise at the onset of the L toned syllable is not a default f0 alignment in this context as f0 often begins to fall from the level of the preceding low target. With HL,

by contrast, both the rise and the fall are perceptually salient. Note that in Figure 21 f_0 for H does not go as high as it does at the beginning of the HL toned syllable. This, however, is not a default difference as the f_0 for H can be as high as that found at the onset of a HL toned syllable. In addition, H in this context can be realised as a rise which continues all the way through the target syllable. To this must be added that the onset of the fall for HL relative to the segmental string in Figure 21 is not the only possible alignment found in this context. The alignment patterns for HL will be discussed in detail in section 6.4.1.

The context in Figure 21, where the contrastive tonemes occur phrase-finally after a L tone (abbreviated as L _ #), can be considered as a base-line against which the realisation of the three tonemes in other contexts can be compared.

In contexts other than L _ #, the distinction between the tonemes is often neutralised. The three realisations for H in Table 7: high, mid and low level, arise as a function of the position of the target syllable with respect to the preceding H toned syllables within the same prosodic domain. For our purposes, a prosodic domain corresponds to a syntactic domain such as a phrase or a clause. Whenever more than one H tone occur in a row within the same prosodic domain, the first of these H tones will have the highest pitch, the pitch of the following H tone will be lower than that of the preceding H but higher than that of the following H. At the beginning of the next prosodic domain pitch gets re-set, so that the first H tone in this new domain is realised at the highest pitch level (albeit the high level will differ for syllables with modal and breathy vowels). The subsequent H tone will be lower in pitch than the preceding H, hence the mid level realisation of the H tone. A H tone that follows it

will be even lower in pitch, hence the low level realisation of the H tone. So far, the maximum number of H tones that occur in the same prosodic domain in my data is three. The last of these H tones is realised near the bottom of the speaker's range. In such position it can be mistaken for a L tone, however, it does not behave as a L tone phonologically. Also, when this H occurs in phrase-final position it is easily distinguishable from the L tone in this position. The H in phrase-final context is realised as a level tone, whilst the L tone in this context is realised with a falling trajectory.

This realisation of the successive Hs is sustained across different speech rates, and as such it cannot be attributed to declination, a process that refers to an overall pitch fall within an utterance (Yip 2002:9).

The pitch realisations for L in Table 7 are also due to its occurrence in different contexts. In phrase-final position it is always realised with a falling f_0 trajectory. We saw earlier that the fall sets off at the onset of the vowel portion (see the last L tone in Figure 21). The level mid/low realisation is found in phrase-medial contexts (for example, the L tone on *càa* in Figure 21). Most often it is found when the L tone is preceded by another L. The f_0 for L in this context does not tend to reach the bottom of the speaker's range. When the preceding tone is H there is usually a drop in f_0 . The drop will be most salient in syllables with long vowels and in slow speech. The drop will be least salient in syllables with short vowels and in fast speech. With the L tone on short vowels in phrase-medial position there is also a pressure to move towards the following target. The low target in such cases could not always be reached

successfully. Hence, L that occurs phrase-medially following a H tone could be realised as a mid/low-level tone (see Table 7).

6.4.1. Pitch target alignment within syllables

In the discussion on the phonetics of tone I will assume that pitch movements (reflected by f0 alignment) are the movements towards pitch targets. Under this assumption, the rising f0 pattern for H on náŋ in Figure 22 can be interpreted as the movement towards the high target. The portion of the rise and the steady (level) state is demarked by curly brackets. We can see that f0 is rising from the low target of the preceding syllable all the way through the vowel portion of the target syllable. The highest point is reached during the portion of the [+sonorant] coda.

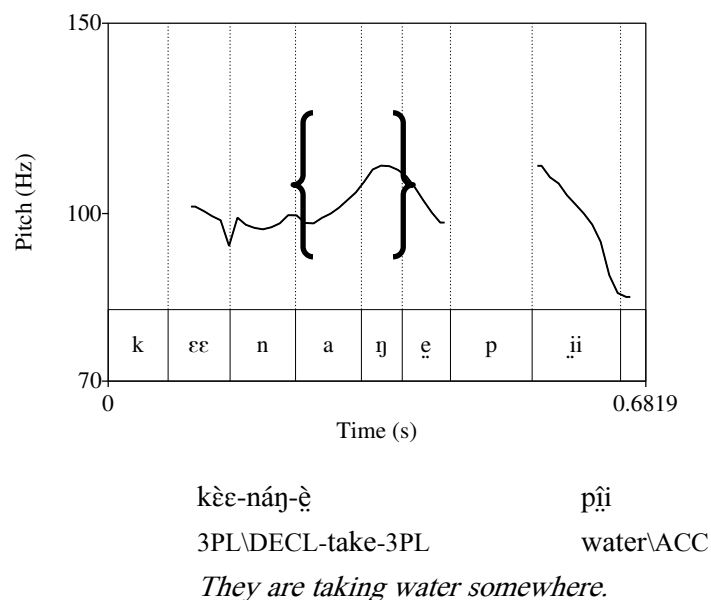
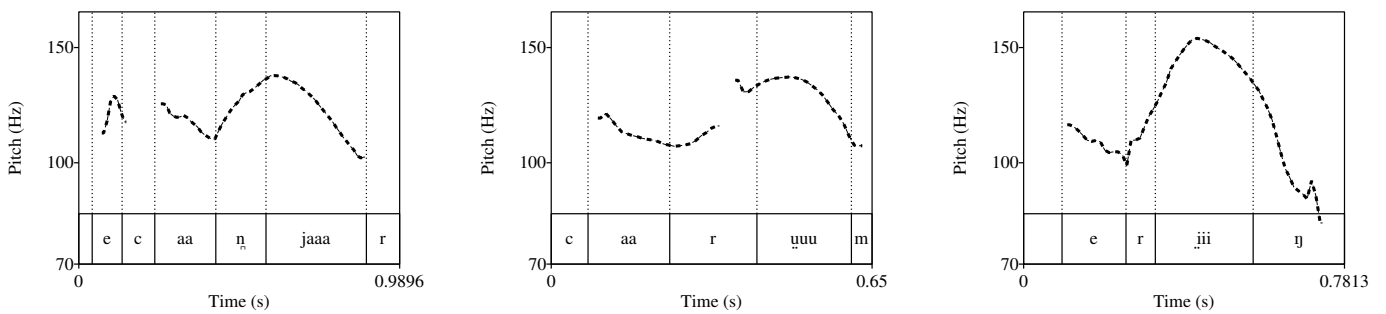


Figure 22. F0 trajectory from low to high pitch targets in a syllable with short vowel. The portion of the rise and the steady state is demarked by curly brackets.

The presence of this rise in Figure 22 tells us that the high pitch target is not reached instantaneously, instead, there is a period of transition from the low target of the preceding syllable. This, to some extent, is due to the physiological reasons as the rate of vocal fold vibrations which regulates f_0 frequency does not tend to change abruptly in normal speech. But this is not the only reason for why the target is not reached earlier. When a H tone follows a L tone, the high pitch target can be reached at the end of the syllable in syllables with short, mid, and long vowels alike. Clearly, rather than being a purely physiological phenomena, this target delay is also a matter of target timing (alignment) within a syllable. Therefore, I claim that pitch targets for level tones are aligned at the end of syllables. This has also been described for other tone languages, most notably by Xu (1998), Xu & Wang (2001), Xu & Liu (2006) for Mandarin Chinese.

Figure 22 also shows that f_0 is realised on the [+sonorant] consonants (see section 4.2.2). These [+sonorant] consonants can occur both at the onset and in coda positions of syllables, hence in such syllables the onset of the movement towards a pitch target could, in principle, start early and finish late. We saw earlier that this is what happens in the case of a HL in Figure 21 where the rise is aligned at the portion of the onset consonant. In Figure 22, by contrast, the movement towards the target does not begin during the [+sonorant] onset. In what follows I will discuss the data on alignment of f_0 in syllables with [+sonorant] onset and coda consonants in order to establish if any reliable heuristics can be given for f_0 alignment in these contexts. In particular, if the assumption that the pitch targets are aligned at the end of syllables is correct, we expect that there will be more regularity in the realisation of f_0 during the [+sonorant] coda portion than during the [+sonorant] onset portion.

Let us first of all examine the alignment of the first pitch target for HL in syllables with [+sonorant] consonants at the onset position. Figure 23 shows the f0 traces for HL following a L tone. In panel A, most of the rise in f0 for HL takes place during the portion of the [+sonorant] consonant at the onset and the fall starts relatively early into the glide-vowel sequence. In panel B, likewise, the rise in f0 takes place over the duration of the [+sonorant] onset /r/, but the fall does not begin until about half-way into the vowel. In panel C, the rise begins during the portion of the [+sonorant] consonant at the onset and it continues half-way into the vowel. From that point onwards the f0 begins to fall and the fall continues until the end of the syllable. Panel A tells us that f0 alignment during the portion of the [+sonorant] onset should be taken into account for the identification of HL. Panels B-C tell us that the alignment of the first target can, in fact, be as late as half-way into the vocalic portion of the syllable. This is especially evident from the f0 trajectory in panel C where the high target is reached at that late point.



Panel A.
 è-càa ηjâaar
It has been liked.

Panel B.
 è-càa rÿuum
It has been finished.

Panel C.
 è-rÿiinj
 ‘he/she/it is running (PET)’

Figure 23. Alignment of the first pitch target for HL in syllables with [+sonorant] onsets following a L tone.

The variation in the alignment of the first pitch target in panels A vs. B-C can be described as early vs. late alignment. This means that in syllables there are two optional positions for the target of the first component of the contour. One position takes into account the onset of voicing, and second position takes into account the onset of the vowel.

Let us now consider the realisation of the three tonemes in syllables with [+sonorant] coda consonants in Figure 24. The panels A-C show f₀ alignment for the three tonemes L, H, and HL, respectively. All words have short vowels and [+sonorant] coda consonants. In panel A the fall in f₀ begins fairly late into the glide-vowel sequence and the low target is reached during the portion of the coda consonant. In panel B the overall pattern is that of a level high tone over the entire syllable (notwithstanding small fluctuations in f₀). In panel C f₀ is high and level for most of the duration of the vowel portion. It begins to fall somewhat at the end of the vowel portion, and the main drop in f₀ occurs during the coda portion. Importantly, the movement towards the low target of the contour is realised entirely over the portion of the stem-final consonant in panel C.

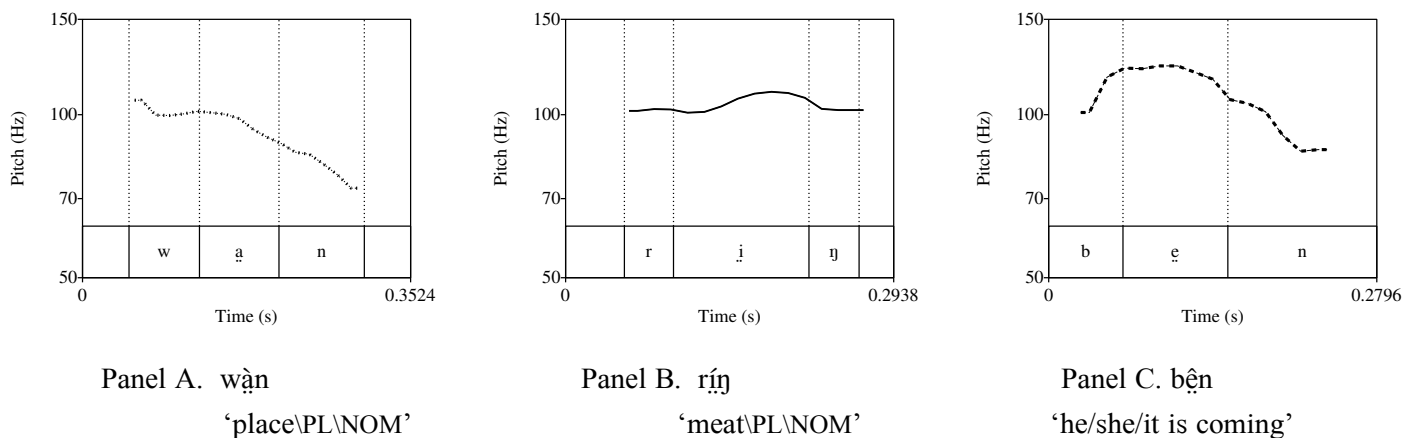


Figure 24. Examples of f0 alignment for the three tonemes in syllables with short vowels and [+sonorant] coda. Panel A – L, panel B – H, and panel C – HL.

F0 alignment for the three tonemes in Figure 24 tells us that in syllables with [+sonorant] coda the pitch target can be aligned on this consonant. In the case of the contour tone, the movement towards the second target can begin at the end of the vowel portion/beginning of the coda consonant. Thus, the realisation of f0 and the perceived pitch pattern on [+sonorant] coda consonant must be taken into account for the identification of a given toneme.

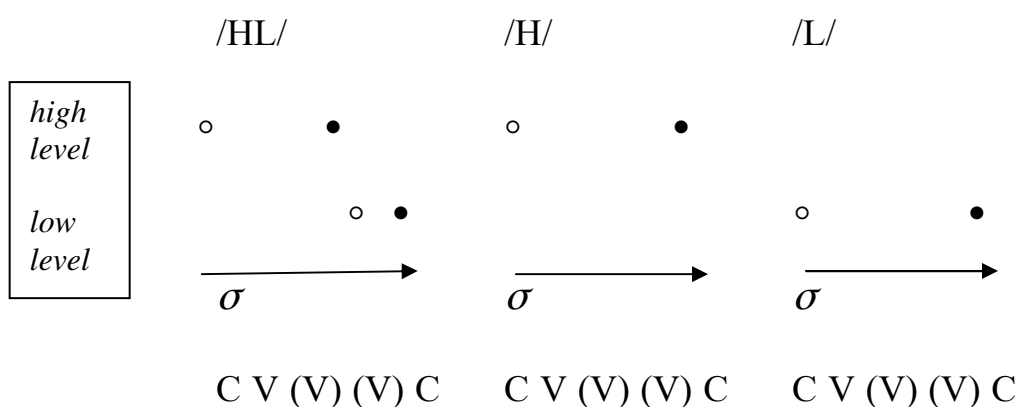
It must be added that in connected speech the movement towards the following target can begin as early as the portion of the coda consonant of the preceding (level toned) syllable. We will encounter such examples in section 6.5. In these cases the anticipatory movements during the portion of the coda consonant is only slight. Such movements can be observed by considering f0 tracks, but they do not appear to be perceptually salient.

6.4.2. Discussion

We saw that f0 alignment for the three tonemes can vary as a function of syllable structure and as a function of context in which the target syllable occurs. We also saw that f0 trajectories tend to vary more at the onsets than at the offsets of syllables. This is compatible with the notion that pitch targets (for level tones) are aligned at the end of syllables.

The representation in (93) gives a schematic account of the alignment of tone in syllables. The consonant (C) and the vowel (V) symbols represent the segmental components of syllables. The arrows above the letters depict the syllable's timing structure. The idea is that the alignment of pitch targets is synchronised within the timing structure of the syllable (after Xu & Liu 2006). The dots represent tone targets (adapted from Gussenhoven 2000). The empty dots symbolise the earliest points at which a target can be reached. The filled dots symbolise the latest points at which a target can be reached. The dots are aligned along the timing structure of a syllable.

(93)



The specification of the two positions (early and late) for a given pitch target allows us to account for the variation in the alignment of these targets. The filled dots can be thought of as the cut off points: the points by which the target must be reached for the successful identification of a given toneme. Whether the target will be reached early or late will vary as a function of context. For example, in a H toned monosyllabic word uttered in isolation the high target will be reached at the onset of voicing which can be as early as the beginning of the [+sonorant] onset consonant. When preceded by a L tone, the high target will be reached late, the latest possible point being [+sonorant] coda consonant. The low target in a L toned monosyllabic word in phrase-final context will be reached at the end of voicing for that syllable. The low target will be reached at the beginning of the syllable when the preceding tone is L and the target syllable occurs in phrase-medial context (since the pitch pattern is mostly level in this context).

As for the HL, the alignment of the first target can also vary between early and late. The early target can be aligned as early as the portion of the [+sonorant] onset consonant, or as late as the end of the vowel portion in syllables with short vowels and [+sonorant] coda consonants. The second target will be reached early when the syllable is closed by a [-sonorant] consonant and late when the syllable is closed by a [+sonorant] consonant.

Finally, it must be noted that this schema tells us only about the f₀ trajectories but it does not tell us anything about the relative height of the pitch targets in different contexts. We saw that the target for a L tone will be relatively lower in phrase-final context than in phrase-medial context following a L tone since in the former context

what counts as a target will be the final low point of the falling trajectory. By contrast, in phrase-medial context following a L tone there might be no drop in f_0 at all. Thus, what is considered to be a low target will vary in different contexts. Similarly, the target for a H tone will be relatively higher at the beginning of the prosodic domain than at the end of it.

In the section on the phonetics of tone in Thok Reel we saw that when words occur in isolation it is often difficult to tell the three tonemes apart and that the addition of the sandhi-neutral preceding context (L tone) helps us to disambiguate the three tonemes. In the following sections I will show that the phonological modifications that the two tonemes (H and HL) undergo can also help us to identify the tonemes.

6.5. Phonological processes

The two Thok Reel tonemes H and HL are subject to sandhi modifications when they are preceded by a H tone. The phonological status of HL can also be altered through its occurrence in a certain context. In this section I will give a description of these processes. It will be followed by a discussion on the status of the HL which I analyse as a composite toneme that consists of the two components H and L.

Phonological processes will be presented using the standard formalism for the phonological rules: $X \rightarrow Y / _ Z$. The interaction between the rules will be expressed in terms of rule ordering. The formalisation of the processes and the postulated ordering of these process should be treated as an ad hoc descriptive device rather than claims about the formalisation of the phonological theory or statements about language faculty. In the transcription I will distinguish between the underlying {H, L, HL}, the phonological /H, L, HL/, and the surface [H, L, HL] representations.

6.5.1. Dissimilatory Lowering

Dissimilatory Lowering is a process that turns H into L when it is preceded by another H. That is, a sequence H.H becomes H.L. Examples in (94) show that the process applies when two H tones are separated by a morphological boundary (94a), or by a word boundary (94b).

- (94) a. [è-míḋ-ì] {L.H.H} → [L.H.L]
 è-míḋ-í
 DECL-feed\AP-2SG
You are eating.
- b. [è-ḋjáaar gùp] {L.H.H} → [L.H.L]
 è-ḋjáaar gùḋP
 DECL-like\1SG skin\PL\ACC
I like the skins.

The evidence that we are dealing with a process of dissimilation in (94) comes from the behaviour of tone in person-number agreement suffixes in verbs (95-96). The 1-2SG agreement suffixes are H toned when the preceding syllable (the verb stem) is L toned (95a). The 1-2PL suffixes are L toned in this context (95b). When the verb stem is H toned (96), all suffixes surface with L tone.

- (95) a. [è-ḋjòom-é] {L.H.H} → [L.H.H]
 è-ḋjòom-é
 DECL-put.in.mouth\AP-1SG
I am putting (something) into my mouth.
- b. [è-ḋjòom-í] {L.H.H} → [L.H.L]
 è-ḋjòom-í rîḋḋ
 DECL-put.in.mouth-2SG meat\SG\ACC
You are putting meat into your mouth.
- b. [è-kèc-kòn] {L.H.H} → [L.H.L]
 è-kèc-kòn
 DECL-bite\AP\R-1PL.INCL
We (incl.) are biting (repeatedly).
- b. [è-kèj-èj] {L.H.H} → [L.H.L]
 è-kèc-èj
 DECL-bite\AP\R-2PL
You (pl.) are biting (repeatedly).

- (96) a. [è-wéer-è]
 è-wéer-é
 DECL-change\AP-1SG
I am changing.
- [è-wéer-ì]
 è-wáaar-ì
 DECL-change\AP-2SG
You are changing.
- b. [è-tjám-kòn]
 è-tjám-kòn
 DECL-sneeze\AP-1PL.INCL
We (incl.) are sneezing.
- [è-tjáam-èj]
 è-tjáam-èj
 DECL-sneeze\AP-2PL
You (pl.) are sneezing.

The 1-2PL suffixes are [L] toned following both L (95b) and H (96b) tone, thus they are {L} underlyingly. The 1-2SG suffixes are [H] toned when preceded by a L tone (95a), and [L] toned when preceded by a H tone (96a). This means that the underlying tone on these suffixes is {H}. Following a H tone, the H on these suffixes undergoes a dissimilatory process that turns it into a L tone. The dissimilatory process neutralises the distinction between H and L in the context of H.

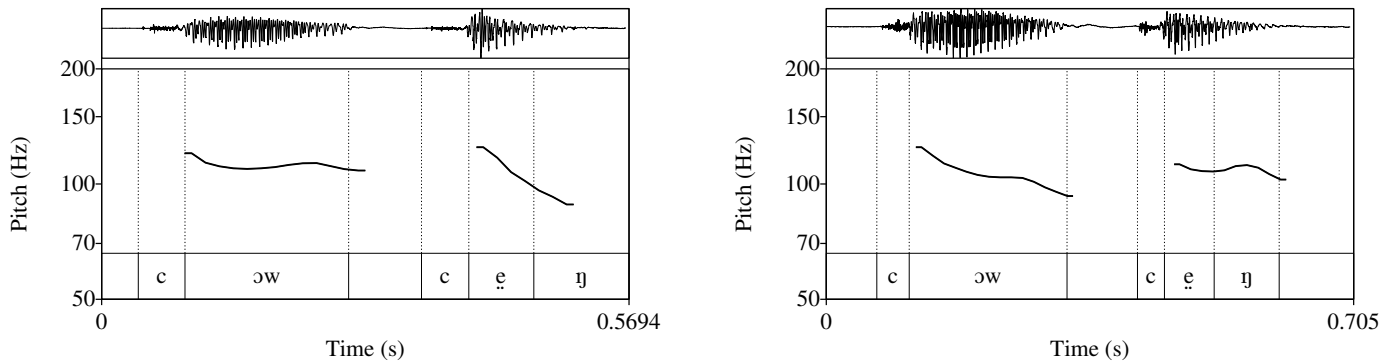
Similarly, when two H tones are separated by a word boundary, the second H tone becomes L. For example, in (97), H toned nouns cẹ̄ŋ and bé̄l appear in two contexts – preceded by H (97a) and by L (97b). In (97a) the H toned ców and ʔóol trigger dissimilation on cẹ̄ŋ and bé̄l, respectively. In (97b) no dissimilation takes place as

both nouns are preceded by a L toned context. Observe that the L toned noun *gàt* appears with L after both H (97a) and L in (97b).

- (97) a. [còw cɛ̃ŋ]
 còw cɛ̃ŋ
 husband\SG\NOM home\SG\GEN
The husband of the homestead.
- [è-hʲɔɔl bèl]
 è-ʔɔɔl bél
 DECL-pound\3SG dura\ACC
He/she is pounding dura.
- [è-dwɛ̃ɛɛc gàt]
 è-dwɛ̃ɛɛc gàt
 DECL-cane\3SG child\SG\ACC
He/she is caning the child.
- b. [còw cɛ̃ŋ]
 còw cɛ̃ŋ
 husband\PL\ACC home\SG\GEN
The husbands of the homestead.
- [è-fiáaal-èj bél]
 è-ʔáaal-èj bél
 DECL-pound-2PL dura\ACC
You (pl.) are pounding dura.
- [è-dwáac-kò gàt]
 è-dwáac-kò gàt
 DECL-cane-1PL.EXCL child\SG\ACC
We (excl.) are caning the child.

Figure 25 shows the f₀ traces for the two noun phrases in (96). In panel A the target word *cɛ̃ŋ* is preceded by a H toned noun, and in panel B it is preceded by a L toned

noun. When the preceding tone is L (panel B), the tone on the target word is H. We can see that f₀ on the target word is fluctuating at the high end of the speaker's range. When the preceding tone is H (panel A), the f₀ on the target word has a falling trajectory. The onset of the fall sets off at the beginning of the vowel.



Panel A. ców cėj ‘husband of the homestead’

Panel B. còw cėj ‘husbands of the homestead’

Figure 25. {H} tone in phrase-final context following H (panel A) and L (panel B).

Earlier I have commented that when the two nouns ców ‘husband\SG\NOM’ (panel A) and còw ‘husband\PL\NOM’ (panel B) are uttered in isolation it is notoriously difficult to tell them apart. Figure 25 shows that with the addition of the following H toned context the behaviour of this H helps to disambiguate the two nouns.

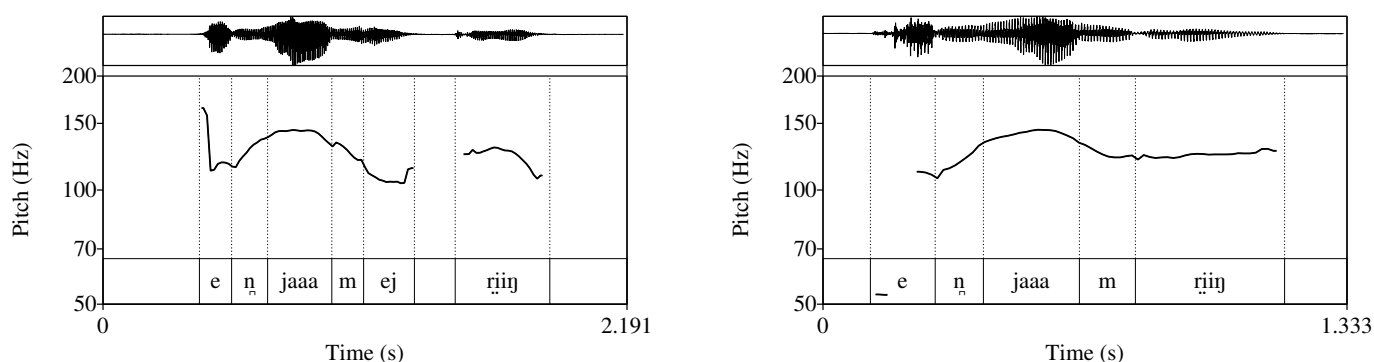
The rule for the dissimilation process is presented in (98). It tells us that H tone becomes L when preceded by another H.

(98) Dissimilatory Lowering

H → L / H __

6.5.2. Contour Simplification

When HL is preceded by H it gets simplified to H. The surface realisation of this H is usually lower in pitch than that of the preceding H tone. In section 6.4 I gave a description of the alignment of the multiple Hs in a phrase. These Hs are the instances of a H followed by one (or more) of the simplified contours. Impressionistically, the simplified contour sounds like a downstepped High. Figure 26 shows pitch tracks for the underlying {HL} on r̥iɪŋ ‘meat\SG\ACC’ preceded by a L tone (panel A), and by a H tone (panel B). In both examples the target word occurs in phrase-final context. We can see that in panel A f0 on the noun has a falling trajectory and in panel B f0 is level high, but somewhat lower than that on the preceding H toned syllable.



Panel A. [è-ŋj́aaam-èj r̥iɪŋ]
 è-ŋj́aaam-èj r̥iɪŋ
 DECL-put.into.mouth-2PL meat\SG\ACC
You (pl.) are putting meat into your mouths.

Panel B. [è-ŋj́aaam r̥iɪŋ]
 è-ŋj́aaam r̥iɪŋ
 DECL-put.into.mouth\1SG meat\SG\ACC
I am putting meat into my mouth.

Figure 26. {HL} after L (panel A) and H (panel B) in phrase-final context. Panel A – surface contour. Panel B – contour simplification after a H tone.

Contour simplification rule is presented in (99). It tells us that HL becomes H when preceded by another H tone.

(99) Contour Simplification

HL → H / H __

6.5.3. Low Deletion

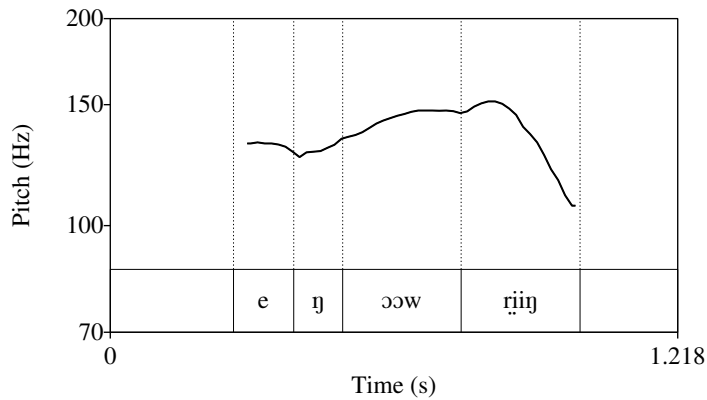
The distinction between HL and H is neutralised when they occur phrase-initially or after a L tone and are followed by some context. In such contexts the L component of the contour gets deleted. Consider the surface realisations of tone in verbs (100).

- (100) a. [è-wáaar-í] {pîi} [L.H.L]
 DECL-change-2SG water\ACC
You are changing the water.
- b. [è-ŋóow-í] {rîiŋ} [L.H.H]
 DECL-vomit-2SG meat\SG\ACC
You are vomiting the meat.
- c. [è-mîiid-í] {gàT} [L.L.H]
 DECL-feed-2SG child\SG\ACC
You are feeding the child.

In (100) the verb stems are preceded by a L toned declarative particle. The surface tone on the verb stems is H in (100a-b) and L in (100c). The surface tone on the 2SG suffix is L in (100a) and H in (100b-c). On the surface we have an apparent controversy: following a H tone on the verb stems the H tone of the suffix dissimilates in (100a) and fails to dissimilate in (100b).

The application or non-application of Dissimilatory Lowering in (100a-b) could be due to the differences between the underlying tone on the verb stems in (100a) and (100b). The H tone on the suffix behaves as if it is preceded by H in (100a), and by L in (100b) (cf. (100c)). This suggests that the tone on the verb stem in (100b) is {HL}. This {HL} must, in turn, undergo a process that results in the surface H tone.

More evidence in support of postulating a {HL} on the verb stem in (100b) comes from the behaviour of a {HL} noun $\dot{r}\dot{i}\dot{n}$ ‘meat\SG\ACC’ following this verb. In section 6.5.2 we saw that the {HL} on this noun gets simplified when it follows a H tone. Following the verb stem in (100b), however, no simplification takes place as is evident from Figure 27. We can see that f_0 is rising from the low target of the first syllable (declarative particle \dot{e} -) and this rise continues all the way through the target syllable (verb $\eta\omega\omega$). F_0 reaches its peak around one-third into the portion of the last syllable (noun). From that point there is a steep fall in f_0 . If the tone on $\eta\omega\omega$ was H, the HL on $\dot{r}\dot{i}\dot{n}$ would simplify to H by Contour Simplification (cf. panel B in Figure 26). Because this does not happen, I infer that $\dot{r}\dot{i}\dot{n}$ is preceded by /L/, which is part of the underlying {HL} on the verb stem. The fact that this {HL} is realised as [H] on the surface means that the second element of the contour gets deleted.



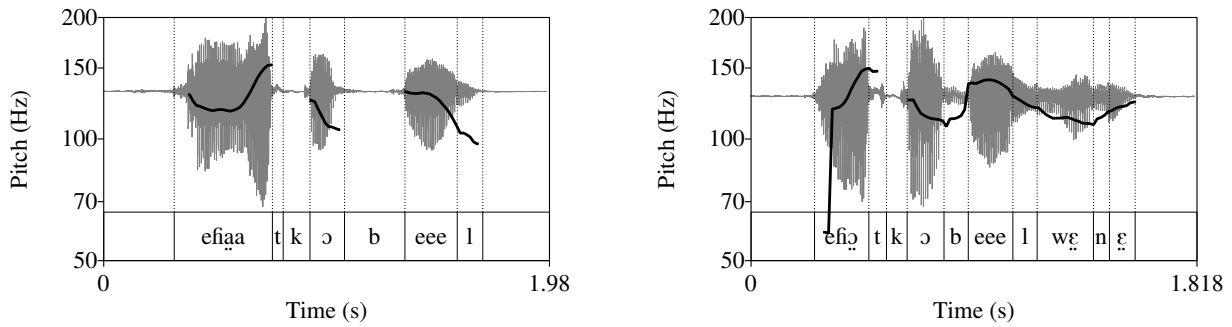
[è-ŋɔɔw riŋŋ]
 è-ŋɔɔw riŋŋ
 DECL-vomit\3SG meat\SG\ACC
He/she/it is vomiting the meat.

Figure 27. The realisation of two adjacent {HL} tones. The first HL is simplified to H.

Because H and HL do not undergo Dissimilatory Lowering and Contour Simplification following a {HL} we can infer that the deletion of the L element of the contour is ordered after Dissimilatory Lowering and Contour Simplification. This, in turn, means that the deletion of the L element of the contour will only take place when the preceding context is non-high, as the preceding H tone would trigger Contour Simplification.

The deletion of the L component of the contour invariably takes place when the target syllable is not the last syllable in an utterance. Compare the realisation of f0 on bêeel ‘dura\GEN’ in Figure 28. In both panels the target word is preceded by a L tone. In panel A the target word is in phrase-final position and in panel B it is in phrase-medial position. In panel A f0 is a plateau high at the onset of the vowel portion and it falls steeply from about half-way into the vowel. The fall continues until the end of voicing (the end of [+sonorant] coda). In panel B f0 is high throughout the vowel

portion and it begins to fall on the coda consonant (mostly, I think, in anticipation of the following L). Impressionistically, the target word is realised with falling pitch in panel A and with high pitch in panel B.



Panel A. [è-háat-kò bêeel]

è-ḡáaT-kò bêeel
 DECL-pound\AP-1PL.EXCL dura\GEN
We (excl.) are pounding dura.

Panel B. [è-hót-kò bêeel wənɛ]

è-ḡótT-kò bêeel wənɛ
 DECL-pound\AP-1PL.EXCL dura\GEN here
We (excl.) are pounding dura here

Figure 28. {HL} in pre-pausal and non-pre-pausal contexts. In both panels the tone on the target word {bêeel} is preceded by a L tone.

In addition, the L component of the contour can be optionally deleted when the target syllable is the last syllable of an utterance. The deletion of L in this position is only found in stems of finite verbs.

The rule of Low Deletion is given in (101). It tells us that the L of the contour deletes when it occurs phrase-initially or after a L tone and is followed by any tonal context (T), except in finite verbs where L can be optionally deleted before an utterance boundary (#).

(101) Low Deletion

$$HL \rightarrow H / \left\{ \begin{array}{c} \# \\ L \end{array} \right\} - \left\{ \begin{array}{c} T \\ \# \end{array} \right\} \quad (\# \text{ optionally in finite verb stems})$$

Interestingly, Low deletion and Contour Simplification produce phonetically different outputs. The H which results due to the application of Contour Simplification is usually lower in pitch than the preceding H tone. By contrast, the output of Low Deletion is a high pitch which is as high that of the average first H tone in a phrase. Compare the f0 tracks in Figure 29. In panel A {HL} on r̄iŋ is simplified by the application of Contour Simplification. In panel B {HL} on r̄iŋ is simplified by the application of Low Deletion. In panel A the [H] on [r̄iŋ] (2nd H) has lower f0 than that of the first [H]. In panel B f0 for [H] on [r̄iŋ] (2nd H) goes almost as high as it does for the first [H].

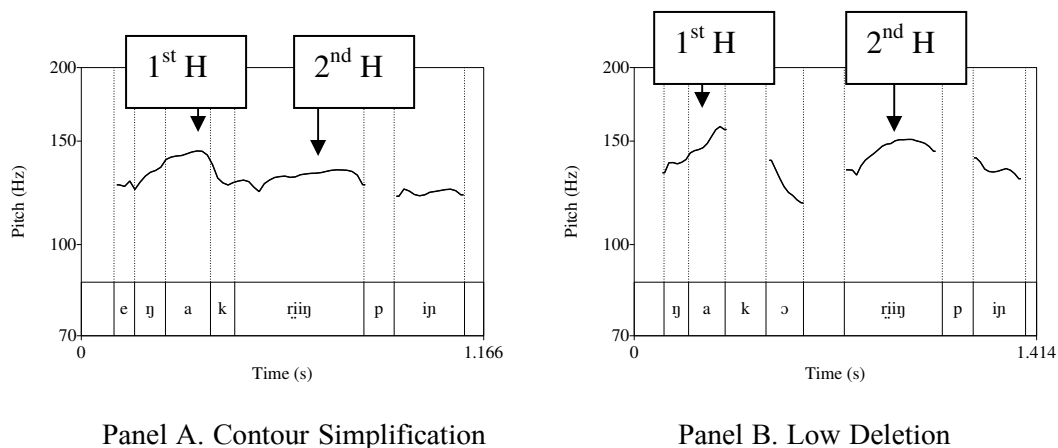


Figure 29. F0 height for H tone by Contour Simplification (panel A) and by Low Deletion (panel B). The target {HL} word r̄iŋ ‘meat\SG\ACC’ occurs in phrase-medial context after a H in panel A and after a L in panel B.

The high realisation of a H tone after a L tone can be contrasted with a phenomenon known as *tone terracing* that is found in many African languages. Tone terracing describes the lowering effect exerted by a L tone on the following H tone. For example, in context H.L.H, the second H will be realised at a lower pitch than the first H due to the intervening L tone. The acoustic data in Figure 32 shows that in Thok Reel there is no tone terracing, but the pitch pattern of a sequence of H tones does exhibit a downwards steps-like effect.

6.5.4. *On the nature of HL*

The behaviour of the HL toneme in Thok Reel raises a question of whether it should be analysed as a composite (H + L) or as a simple tone. On one hand, the application of the Low Deletion suggests the composite interpretation of the contour. On the other hand, cross-linguistically, a process that affects a H tone is also expected to affect a composite HL in the same way (Goldsmith 1990:39-44). In Thok Reel, the HL and H behave differently when preceded by a H tone: HL gets simplified and H gets dissimilated. Contour Simplification and Dissimilatory Lowering result in phonologically different outputs, H and L, respectively.

I analyse the contour tone in Thok Reel as a composite (H + L) on the basis of the application of Low Deletion. As for the difference in the behaviour of H and HL following a H tone, I hypothesise that this could be due to the diachronic differences between the synchronic H and HL. For example, we could envisage a system with Low, Mid and High tonemes that developed into a L, H and HL, respectively. Such development could be explained by the pressure to keep the tonemes perceptually

distant within the narrow frequency range in which the contrastive pitch levels are realised in Thok Reel (see section 6.4). This development could have been followed by a re-analysis (e.g. ex-High reanalysed as HL but fails to behave as the ex-Mid and the synchronic H tone), rendering the synchronic HL's unusual behaviour. It is likely that the origins and the development of the tonemes in Thok Reel will forever remain a mystery. Synchronically, the contour tone in Thok Reel is typologically unusual.

6.5.5. Summary

In this section we saw that there are two main sandhi processes in Thok Reel: Dissimilatory Lowering and Contour Simplification. Both are triggered by a H tone, and apply to the following H and HL tones, respectively. The output of Dissimilatory Lowering is a L tone and the output of Contour Simplification is a H tone. We also saw that the distinction between the H and HL is neutralised when they occur phrase-initially or after a L tone and are followed by some context. In these contexts HL is simplified to H by Low Deletion. On the basis of the application of Low Deletion I analyse HL as a composite tone. Since Low Deletion does not occur when the preceding tone is H, I have hypothesised that Contour Simplification is ordered before Low Deletion. In the next section I we will see that ordering of the three processes in polysyllabic words, phrases and sentences is actually fairly complex.

6.6. Tonal processes in words, phrases and sentences

The most complex aspect of the tone system in Thok Reel is the interaction of the tonal processes in words that exceed one syllable, in phrases and in sentences. In this section I will discuss the rule ordering and the application of the processes in different domains. In 6.6.1 I will discuss the differences in the surface patterns for the two speakers whose data I have considered. I will claim that these differences are due to the differences in rule ordering. I will show that for one of the speakers rule ordering varies in different syntactic contexts. This will lead me to hypothesise about the word and phrase vs. sentence levels. In 6.6.2 I will discuss the sandhi processes in sentences with different types of verbs: finite transitive, finite antipassive and auxiliary. The application of sandhi in sentences with finite transitive verbs will lead me to hypothesise that the onset and the direction of sandhi processes in such sentences are conditioned by a syntactic relation between the verb and the object. In section 6.6.3 I will attempt to explain the sandhi processes in sentences with finite transitive verbs in the light of Precompilation theory (Hayes 1990). We will see that it allows us to explain the tonal behaviour in such sentences without having to postulate the direct syntax-phonology connection. In 6.6.4 I will discuss the relative ordering of Low Deletion and Contour Simplification, and in 6.6.5 I will present additional data on tone behaviour in sentences with past tense auxiliary *cé*. The discussion will lead me to postulate an additional process: tone Replacement and to hypothesise that Replacement and optional Dissimilatory Lowering apply at the surface level in sentences with *cé*.

6.6.1. Rule ordering in two idiolects

The analysis of Low Deletion given in section 6.5.3 was based on the data from a speaker DKNh. The same data elicited from another speaker, JRK, shows surface patterns that deviate from that of DKNh. For example, where DKNh has [H.HL] and [H.H], JRK has [H.H] and [H.L], respectively. This could be either due to the difference in the underlying tone for some of the lexical items or to the differences in the ordering of Low Deletion vs. Contour Simplification and Dissimilatory Lowering. In this section I will examine both options and will argue that the difference is in terms of rule ordering. The two speakers, DKNh and JRK, come from the two Atut sections: Jilek and Luac, respectively. Recall that I have decided to treat the differences found in the speech of the two speakers as the differences between idiolects rather than dialects for the reason that I have not yet confirmed my findings with a representative number of speakers from the two sections.

In section 6.5.3 we saw that in order to explain the non-application of Contour Simplification in sentences like that in (102a) we must assume that Low Deletion is ordered after Contour Simplification (and Dissimilatory Lowering). This explains the surface differences between the examples in (102a) and (102b) where the verb stems have different underlying tone: {HL} in (102a) and {H} in (102b). The examples in (102) were elicited from the speaker DKNh.

- (102) a. [è-ŋɔ̀w r̥i̯i̯ŋ] {L.HL.HL} → [L.H.HL]
 è-ŋɔ̀w r̥i̯i̯ŋ
 DECL-vomit\3SG meat\SG\ACC
He/she/it is vomiting the meat.
- b. [è-ŋjám r̥i̯i̯ŋ] {L.H.HL} → [L.H.H]
 è-ŋjám r̥i̯i̯ŋ
 DECL-put.into.mouth\1SG meat\SG\ACC
I am putting meat into my mouth.

Consider the same sentences uttered by a speaker JRK (103). We can see that the two sentences have identical surface pattern.

- (103) a. [è-ŋɔ̀w r̥i̯i̯ŋ] [L.H.H]
 DECL-vomit\3SG meat\SG\ACC
He/she/it is vomiting the meat.
- b. [è-ŋjám r̥i̯i̯ŋ] [L.H.H]
 DECL-put.into.mouth\1SG meat\SG\ACC
I am putting meat into my mouth.

The first explanation for the surface differences in (102a) and (103a) is that the verb $\eta\omega w$ has different underlying tone for the two speakers. Under this interpretation, the underlying tone on the verbs like $\eta\omega w$ is {HL} for DKNh and {H} for JRK.

However, this could not be the case, as in JRK's speech the verbs that appear to be underlyingly {HL} for DKNh, surface with [HL] when they occur in phrase-final position (104a). When this verb stem is followed by a H toned suffix (104b), the tone on the verb stem is realised as [H] and the tone on the following suffix is subject to Dissimilatory Lowering. Compare (104b) to the surface pattern for DKNh in (104c).

- (104)
- a. JRK
 [è-d̥ɛw] {L.HL} → [L.HL]
 è-d̥ɛw
 DECL-separate\AP\3SG
He/she/it is separating.
- b. JRK
 [è-d̥ɛw-ɨ̃] {L.HL.H} → [L.H.L]
 è-d̥ɛw-ɨ̃
 DECL-separate\AP-2SG
You are separating.
- c. DKNh
 [è-d̥ɛw-ɨ̃] {L.HL.H} → [L.H.H]
 è-d̥ɛw-ɨ̃
 DECL-separate\AP-2SG
You are separating.

Examples in (104a-b) suggest that in JRK's idiolect the application of Low Deletion precedes the application of Dissimilatory Lowering. By the same token, we can assume that in (103a) the application of Low Deletion precedes the application of Contour Simplification. Thus, the differences between the two idiolects are in terms of rule ordering. For DKNh Dissimilatory Lowering and Contour Simplification are ordered before Low Deletion and for JRK Low Deletion is ordered before Dissimilatory Lowering and Contour Simplification.

In fact, for JRK the application of Low Deletion precedes Dissimilatory Lowering and Contour Simplification in all contexts that I have considered so far. By contrast, in DKNh's speech rule ordering varies in different contexts. Consider example (105). The surface pattern for this sentence is identical for the two speakers.

(105)	[è-fìt-kò béeel wɛ̀nɛ́]		
	è-ʔᵛT-kò	bêeel	wɛ̀nɛ́
	DECL-pound\AP-1PL.EXCL	dura\GEN	here
	<i>We (excl.) are pounding dura here.</i>		

This example was already presented in section 6.5.3 (Figure 28) where we saw that the Low Deletion is triggered on {bêeel} with the addition of the following context. Observe that in (105) Dissimilatory Lowering applies to the underlying {H} on the syllable following {bêeel} which is the first syllable of the adverb wɛ̀nɛ́. This means that the output of the Low Deletion feeds Dissimilatory Lowering. In other words, Low Deletion is ordered before Dissimilatory Lowering. The surface output in (105) is an expected outcome given the rule ordering for JRK, but it is not expected given the rule ordering for DKNh. We saw in (102a) that for DKNh Dissimilatory Lowering applies before Low Deletion. So, how the surface pattern in (105) can be explained for DKNh's idiolect?

Observe that the adjacent {HL.H} occur in different syllables of the same word (verb stem + suffix) in (104c) and within the same phrase (verb phrase) in (102a). In (104c) we are dealing with a morphological constituent (word) and in (102a) we are dealing with a close syntactic constituent. In (105) the sequence {HL.H} results from the juxtaposition of a noun and an adverb. Nouns and adverbs do not form close constituents. Clearly, there are structural differences between the examples in (102a) and (105). I hypothesise that in DKNh's idiolect Dissimilatory Lowering precedes Low Deletion at the same level of derivation. This level can be either a word-level or a phrase-level (e.g. noun phrase or a verb phrase). An adjacency of words that are not part of the same phrase (like noun and adverb in (105)) creates a conditioning context for the application of Low Deletion (see rule (101)). Thus, in (105) Low Deletion

applies first. The output of Low Deletion, a /H/ tone, is fed into the next level of derivation which I preliminary describe as sentence level, although the term ‘sentence level’ is more appropriate for the phenomena such as sentence intonation. At this level, sandhi applies to the sequence H.H where the first H is the output of Low Deletion, and the second H is the underlying tone on the following syllable.

In this section I have argued that the differences in rule ordering between the two idiolects is responsible for the surface differences. The derivation for the sentences (102a) and (103a) are given in (106a) and (106b), respectively. We can see that for DKNh (106a) Contour Simplification is ordered before Low Deletion, and for JRK (106b) Low Deletion is ordered before Contour Simplification.

(106)

a. DKNh's idiolect (Jilek section)

{è-ηδωw r̥iŋ} *He/she/it is vomiting the meat.*

{L.HL.HL} *underlying pattern*

----- Contour Simplification }
/L.H.HL/ Low Deletion } *word & phrase level*

[L.H.HL] *surface pattern*

[è-ηδωw r̥iŋ]

b. JRK's idiolect (Luac section)

{è-ηδωw r̥iŋ} *He/she/it is vomiting the meat.*

{L.HL.HL} *underlying pattern*

/L.H.HL/ Low Deletion }
/L.H.H/ Contour Simplification } *word & phrase level*

[L.H.H] *surface pattern*

[è-ηδωw r̥iŋ]

I have said that for DKNh we must further distinguish between word- and phrase-level vs. sentence-level in order to account for the apparent differences in rule ordering. The rule ordering at the sentence-level is given in (107).

(107)

{è-ʔᵛT-kᵛ bēeel wᵛᵛᵛ}

We (excl.) are pounding dura here.

{L.H.L.HL.H.H}

underlying pattern

/L.H.L.H.H.H/

Low Deletion

/L.H.L.H.L.H/

Dissimilatory Lowering

}
}

sentence level

[L.H.L.H.L.H]

surface pattern

[è-ḥᵛᵛᵛ-kᵛ bēeel wᵛᵛᵛ]

6.6.2. Serial sandhi

In this section I will present a descriptive analysis of the interaction of sandhi processes in sentences with finite transitive verbs, finite antipassive verbs and auxiliary verbs. Under the discussion will be the onset and the direction of the sandhi processes in sentences where more than two non-low tones occur in a row.

Consider example in (108) where three underlying {H} tones occur in a row: on the transitive verb stem, on the agreement suffix, and on the object noun. On the surface only the first of these {H} tones (on the verb stem) remains unchanged. The other two {H} tones (on the suffix and on the noun) are realised as [L] in this context. This means that the {H} tone on the verb stem is responsible for the dissimilation of the {H} tone on the suffix which itself triggers Dissimilatory Lowering of the {H} tone on the noun.

- (108) [è-fìḡḡal-ì bəl] {L.H.H.H} → [L.H.L.L]
 è-ḡḡḡal-ì bəl
 DECL-pound-2SG dura\ACC
You are pounding dura.

Similarly, when two underlying {H} tones are followed by a {HL} in the same type of sentence as that in (108), only the first tone (H) remains unchanged on the surface (109). The second {H} surfaces as [L] and the {HL} surfaces as [H]. Here, the {H} on the verb triggers Dissimilatory Lowering of the {H} on the suffix which itself triggers Contour Simplification on the noun.

- (109) [è-gḡoor-ì rìḡḡ] {L.H.H.HL} → [L.H.L.H]
 è-gḡoor-ì rìḡḡ
 DECL-want-2SG meat\SG\ACC
You want some meat.

In the negated version of the sentence in (108), a {H} toned negation particle precedes the verb stem (110). We can see that Dissimilatory Lowering applies to every H that follows the H on the negation particle.

- (110) [è-tìl-fìḡḡal-ì bəl] {L.H.H.H.H} → [L.H.L.L.L]
 è-tìl-ḡḡḡal-ì bəl
 DECL-NEG-pound-2SG dura\ACC
You are not pounding dura.

So, if more than two H tones occur in a row, sandhi processes apply to every H tone following the first one. What is interesting is that the conditioning context for the application of sandhi in (108-110) is not evident from the surface realisations as it is removed by the application of other sandhi processes. For example, by looking at the

surface representation in (110) we can account for the dissimilation of the {H} on the verb stem as the preceding tone is [H] on the surface, but we cannot account for the dissimilation of the tone on the suffix and the noun as on the surface these are preceded by [L] tones. This could mean that sandhi processes have access to the underlying tone. This has been postulated for Luanyjang Dinka (Remijsen & Ladd 2008).

Another possibility is that the sandhi processes in (108-110) start at the right edge of a phrase and apply in a left-to-right fashion to every two adjacent non-low tones. This point is exemplified in (111) where the lines under the letters delimit the scope of the application of sandhi. The lines move from right to left in an utterance with four high tones in a row (cf. (110)). The direction of the actual processes is from left to right within each underlined sequence, as it is the second of every two H tones that dissimilates.

(111) {H.H.H.H}
 /H.H.H.L/
 /H.H.L.L/
 /H.L.L.L/
 [H.L.L.L]

The evidence against these two possible analyses comes from the examples where Contour Simplification is triggered in syllables preceded by the underlying {HL} but not by the underlying {H} (112). In these examples the {H} and {HL} toned nouns,

(112a) and (112b), respectively, are preceded by a {H} tone on the auxiliary verb and followed by a {HL} on the infinitive.⁴

(112)

a. [è-cé /gùp/ njâaar] {L.H.H.HL} → [L.H./L/.HL]
 è-cé gùP njâaar
 DECL-PST\MSG skin\PL\ACC like\TRANS
I have liked the skins.

b. [è-cé /tèet/ njâaar] {L.H.HL.HL} → [L.H./H/.H]
 è-cé tèeT njâaar
 DECL-PST\MSG hand\PL\ACC like\TRANS
I have liked the hands.

If we assume that sandhi starts at the right edge of the utterance, then we would expect that contour tone on the infinitive in (112a) will be simplified first by the application of Contour Simplification. In (112b) no Contour Simplification is expected to take place, since the preceding tone is {HL}. In fact, the situation is the reverse – Contour Simplification on the infinitive applies in (112b) but not in (112a). What this means is that Contour Simplification takes place after the tone on the nouns has been modified by the application of Dissimilatory Lowering in (112a) and Contour Simplification in (112b). Thus, the processes must first take place at the left edge of the sentences in (112). The H tone on the auxiliary serves as the conditioning context for the application of sandhi on the nouns. In (112a) the {H} on the noun becomes /L/ and in (112b) the {HL} on the noun becomes /H/.

⁴ Please note that some additional processes modify the tone on the nouns in sentences in (112). They will be discussed in section 6.6.5. In the meantime, the nouns in the two examples in (112) will be represented between the slashes.

The behaviour of tone on the infinitive is crucial to our discussion here. First, it shows that in these sentences sandhi processes do not start at the right edge of the utterance. Second, the fact that the process of Contour Simplification applies in (112b) but not in (112a) tells us that sandhi does not have access to the underlying tone. If it did, we would have expected that Contour Simplification would apply in (112a) where the underlying tone is {H} but not in (112b) where the underlying tone is {HL}. The fact that this does not happen means that sandhi only has access to the output of any preceding sandhi processes.

So, we are left with a controversy. On one hand, in examples like that in (108-110) every underlying {H} triggers sandhi processes on the following non-low context irrespective of whether this {H} itself undergoes Dissimilatory Lowering. On the other hand, in examples like that in (112a) the underlying {H} fails to trigger sandhi processes by virtue of undergoing Dissimilatory Lowering itself.

This, however, is only an apparent controversy based on an assumption that sandhi is a purely phonological phenomenon. I will show that the order and the direction of the application of sandhi processes in Thok Reel are determined by syntax, and in particular, by the relation between the finite verb and the object of the clause.

Evidence for the role of syntax in the application of sandhi processes comes from the examples like that in (113). There, the finite verb is antipassive. When the object is present in a clause with the antipassive verb (113b-c) it takes genitive case.

- (113) a. [è-míḏ-ì] {L.H.H} → [L.H.L]
 è-míṭ-í
 DECL-feed\AP-2SG
 You are feeding (on something).
- b. [è-mít rjêŋ] {L.H.HL} → [L.H.H]
 è-míṭ rjêŋ
 DECL-feed\AP\3SG meat\SG\GEN
 He/she/it is feeding on meat.
- c. [è-míḏ-ì rjêŋ] {L.H.H.HL} → [L.H.L.HL]
 è-míṭ-í rjêŋ
 DECL-feed\AP-2SG meat\SG\GEN
 You are feeding on meat.

In clauses with H toned antipassive verbs, such as that in (113), Contour Simplification and Dissimilatory Lowering apply to the context that follows the verb stem. In (113a) Dissimilatory Lowering dissimilates the H on the suffix. In (113b) Contour Simplification levels the HL on the object noun. When the object noun follows the antipassive verb than ends on a H toned suffix (113c), only the tone on the suffix changes as a result of the application of Dissimilatory Lowering. No sandhi process applies to the tone on the noun. Compare the example in (113c) to the examples (108-110) where sandhi processes on the noun in object position are triggered by the H on the verb suffix which itself dissimilates (becomes L) by Dissimilatory Lowering. The difference between the sentences in (113) and (108-110) is that in (113) the finite verb is antipassive and in (108-110) the finite verb is transitive. The transitive verb and its object form a close constituent. On the other hand, the antipassive verb and the object, by definition, do not form a constituent (see section 2.3). In the light of this evidence, I hypothesise that the processes of Contour

Simplification and Dissimilatory Lowering are used by syntax to signal the relationship between the close constituents.

The way that I propose to analyse sandhi in sentences with the finite transitive verbs is to assume that the application of the processes which tie the object to its verb precede the application of all other processes. For example, in (110) repeated in (114), sandhi first applies between the verb and the object. The H that triggers Dissimilatory Lowering in (114) is actually the H tone on the subject agreement suffix. Once the process that marks the juncture between the verb and its object has applied, the Dissimilatory Lowering applies again to adjacent sequences of H to the left of the juncture, that is, between the H of the verb stem and the H of the suffix. The first of these H tones (H on the verb stem) triggers the dissimilation of the second H (H on the suffix). In this way, the {H.H.H} becomes [H.L.L]. With the addition of the negation particle, the process is repeated again, this time the H on the verb stem undergoes Dissimilatory Lowering, thus the underlying sequence {H.H.H.H} becomes [H.L.L.L]. In other words, sandhi apply to sequences of non-high tones starting from the point of the juncture between the finite transitive verb and its object. In (114) the lines under the letters signal which two adjacent tones are being considered by sandhi at any given time. The lines move from right to left but the direction of the actual processes is from left to right within each underlined sequence.

- (114) {è-tíl-ṙṙṙṙl-ṙ bél} *You are not pounding dura.*
 {L.H.H.H.H} *underlying tone*
 /L.H.H.HL/ Dissimilatory Lowering (verb + object)
 /L.H.H.L.L/ Dissimilatory Lowering (verb stem + suffix)
 /L.H.L.L.L/ Dissimilatory Lowering (NEG + verb stem)
 [L.H.L.L.L] *surface tone*
 [è-tíl-ṙṙṙṙl-ṙ bèl]

When the object noun is followed by some context, as it is in (115), the output of the syntactic sandhi between the transitive verb and its object will serve as the input to other sandhi processes to the right of the noun. Thus, the {HL} in the object noun becomes /H/ by the application of Contour Simplification and this /H/ then triggers the application of Dissimilatory Lowering on the following syllable (the first syllable of the adverb).

- (115) [è-góoor-ṙ rṙṙṙ wṙṙṙṙ]
 è-góoor-ṙ rṙṙṙ wṙṙṙṙ
 DECL-want-2SG meat\SG\ACC here
You want some meat here.

When the finite verb and the object do not form a close constituent, as it is in the case where the finite verb is antipassive, the sandhi starts at the left edge of the utterance by default. The sandhi proceeds from left to right turning sequences of {H.H} or {H.HL} into /H.L/ and /H.H/, respectively. In the case of a {H} toned antipassive verb with a {H} toned suffix, the output Dissimilatory Lowering does not provide the conditioning context for the application of sandhi on the following noun (116), thus its tone remains unchanged on the surface.

- (116) {è-míT-í rjêŋ} *You are feeding on meat.*
 {L.H.H.HL} *underlying tone*
 /L.H.L.HL/ Dissimilatory Lowering (verb stem + suffix)
 [L.H.L.HL] *surface tone*
 [è-míd-ì rjêŋ]

Similarly, in sentences given in (112), repeated in (117), sandhi starts at the left edge of the utterance. In (117a) the {H} toned noun that follows the {H} toned auxiliary dissimilated by Dissimilatory Lowering. The output of this process (/L/ tone) does not provide the conditioning context for the application of Contour Simplification on the infinitive. By contrast, when the {HL} toned noun follows the {H} toned auxiliary (117b), the output of the Contour Simplification (/H/ tone) provides the conditioning context for the application of Contour Simplification on the infinitive.

- (117) a. {è-cé gúp njâaar} *I have liked the skins.*
 {L.H.H.HL} *underlying tone*
 /L.H.L.HL/ Dissimilatory Lowering (auxiliary + noun)
- b. {è-cé téeT njâaar} *I have liked the hands.*
 {L.H.HL.HL} *underlying tone*
 /L.H.H.HL/ Contour Simplification (auxiliary + noun)
 /L.H.H.H/ Contour Simplification (noun + infinitive)

I have shown that the default direction of sandhi processes is left-to-right starting at the left edge of an utterance, except in sentences with the finite transitive verbs. In

these sentences the point from which the sandhi processes start is determined by syntax. The syntactic function of sandhi processes has also been reported for some of the Mandarin dialects (Chen 1990). We saw that in Thok Reel the first application of sandhi in sentences with finite transitive verbs takes place at the right edge of the verb, marking a juncture between the verb and its object. From the point of this juncture sandhi proceeds in two directions, to the left of the juncture and to the right of it. The leftwards direction refers to the selection of the two tones that are being considered by sandhi at any given point in the derivation, and not to the direction of the sandhi application. The application of sandhi in all cases is from left-to-right, where the leftmost of two adjacent tones is the trigger and the rightmost tone is the undergoer of a sandhi process.

What is unusual about sandhi in sentences with finite transitive verbs is that the application of sandhi processes across a word boundary (e.g. verb and object) takes place before the application of sandhi processes across a morphological boundary (e.g. verb and suffix). Cross-linguistically, phonological processes first apply within words and then between words in an utterance. This has been captured by the theory of Lexical Phonology which distinguishes between lexical phonological rules (which work at the morphological level) and postlexical phonological rules (which apply at the sentence level). It is predicted that the lexical phonological rules must precede postlexical rules (Kiparsky 1982; cited in Gussenhoven & Jacobs 1998:109). The Thok Reel data from sentences with finite transitive verbs suggests that postlexical phonological rules precede lexical phonological rules. In the next section I will try to account for the application of sandhi in sentences with finite transitive verbs in the light of the Precompilation theory proposed by Hayes (1990).

6.6.3. Precompiled phrasal phonology

The Precompilation theory was proposed by Hayes (1990) in order to resolve cases like that in Thok Reel where the phonological processes appear to be governed by syntax. In this theory, the class of lexical rules (rules that apply pre-syntactically) is extended to include the rules which derive allomorphs for certain word classes. These rules are referred to as *precompiled* rules. The precompiled rules may utilise the set of rules used in lexical phonology.

Hayes proposes that the lexicon of a language consist of what he terms *phonological instantiation frames* which represent the contexts for the phonological instantiation of words (Hayes 1990:93-94). For example, in Thok Reel a phonological instantiation frame 1 (118) will specify the context for the phonological instantiation of nouns that occur in object position of finite transitive verbs with a H tone at the right edge.

(118)

Frame 1: / [VP finite transitive verb H _ ...]

Grammar will then automatically generate the allomorphs for every phonological instantiation frame. In Thok Reel, the two allomorphs will be generated in the way shown in (119a) for the {H} toned noun *bél* ‘dura\ACC’, and in (119b) for the {HL} toned noun *rîij* ‘meat\SG\ACC’.

- (119) a. bəl input
 bəl bəl_[Frame 1] outputs
- b. r̥iŋ input
 r̥iŋ r̥iŋ_[Frame 1] outputs

Hayes proposes that the frames are included into the structural description of the phonological rules. Since in Thok Reel there are two rules: Dissimilatory Lowering and Contour Simplification, frame 1 will be included into the structural description of both rules (120).

- (120) Dissimilatory Lowering Contour Simplification
- $H \rightarrow L / H _ \text{[H Frame 1]}$ $HL \rightarrow H / H _ \text{[HL Frame 1]}$

The processes in (120) will then apply to the forms in (119) in the way presented in (121).

- (121) a. bəl bəl_[H Frame 1] inputs (from 119)
 bəl bəl_[H Frame 1] outputs
- b. r̥iŋ r̥iŋ_[HL Frame 1] inputs (from 119)
 r̥iŋ r̥iŋ_[HL Frame 1] outputs

One of the benefits of the Precompilation theory is that we can avoid postulating a direct interaction between phonology and syntax by assuming that the forms which slot into the syntactic structure are already phonologically precompiled to fit that structure⁵.

Precompilation also allows us to postulate a uniform left-to-right direction of sandhi which begins at the left edge of the utterance for all Thok Reel sentences. Recall that the analysis proposed in section 6.6.2 rested upon the assumption that sandhi begins at the point of the finite transitive verb-object juncture and then proceeds to the left of this juncture. Explaining the behaviour of tone in these object nouns in terms of precompilation means that the sandhi processes in sentences like that in (122) start at the left edge of the sentence, and thus the {H} tone on the suffix in (122) becomes /L/ by Dissimilatory Lowering.

- (122) a. [è-híɔɔl-ì bəl̩]
- | | | |
|-------------------------------|----------|--|
| è-ɣɔɔl-í | bəl̩ | allomorph: bəl̩ _[H Frame 1] |
| DECL-pound-2SG | dura\ACC | |
| <i>You are pounding dura.</i> | | |
- b. [è-góoor-ì r̩iŋ]
- | | | |
|----------------------------|-------------|---|
| è-góoor-í | r̩iŋ | allomorph: r̩iŋ _[HL Frame 1] |
| DECL-want-2SG | meat\SC\ACC | |
| <i>You want some meat.</i> | | |

However, explaining the behaviour of tone in nouns in object position of the finite transitive verbs in terms of precompilation raises another issue. Consider (123) where

⁵ A similar proposal is Shattuck-Hufnagel (1983)'s Frame and Filler model.

the precompiled allomorph of a {HL} toned noun follows a {H} toned suffix that does not dissimilate (by virtue of being preceded by a L tone on the verb stem). In this case the allomorph is H toned, and in principle, it could be subject to a purely phonological sandhi process of Dissimilatory Lowering triggered by a H toned suffix. Since in (123) the noun is [H] on the surface, the analysis must include some mechanisms that prevent sandhi from applying in such cases.

- (123) [è-nòooŋ-í ríiŋ]
 è-nòooŋ-í ríiŋ allomorph: ríiŋ_[HL Frame 1]
 DECL-bring-2SG meat\SG\ACC
You are bringing a piece of meat.

Analysing the behaviour of tone on nouns in terms of precompilation still leaves us with a question: how can we explain cases like that in (124) where the sequence of three {H} tones within the verb becomes [H.L.L]?⁶

- (124) [è-tí-l-fìjòol-ì bèl] {L.H.H.H.H} → [L.H.L.L.L]
 è-tí-l-fìjòol-ì bél
 DECL-NEG-pound-2SG dura\ACC
You are not pounding dura.

It could be that the sandhi processes within words apply in one go. That is, if more than one non-high tone occurs in a row within a given word, the first non-low tone acts as a trigger for the application of sandhi to the following non-high tones (thank you to Peter Ackema for pointing this out to me). This interpretation also poses a question of whether in negated sentences where a verb stem is {HL} and the suffix is

⁶ Recall that I treat the negation particle as part of the verbal affixation (see section 3.4).

{H} both Dissimilatory Lowering and Contour Simplification would apply simultaneously. If they do, we may categorise them as sub-processes of the same macro process. Unfortunately, I do not have the relevant data, thus, this issue remains to be investigated during my next data collection trip.

If the sandhi processes apply simultaneously within transitive verbs, then we also expect to see the same simultaneous application within the antipassive verbs (e.g. when the antipassive is negated and the stem is followed by a H toned suffix). Here again, I do not have the relevant data at my disposal.

Analysing processes that occur within words differently than those that occur between words also implies a division between lexical and postlexical rules. In other words, we would assume that the processes which take place at the lexical level apply before the processes that occur at postlexical (syntactic) level. There is however, evidence against this analysis. Earlier I have given an example that shows the application of Dissimilatory Lowering to the first H tone on the adverb *wɛ́nɛ́* 'here'. The relevant example is repeated in (125a). If the assumption that the processes at the word level precede the application of the processes across word boundaries was correct, then the second H on the adverb should have always surfaced as L, since it is preceded by an underlying {H} of the first syllable. In fact, the second syllable is [L] toned on the surface only when the preceding syllable is [H] toned (125b), and it surfaces as [H] when the tone on the preceding syllable is /L/ through the application of Dissimilatory Lowering. This means that in *wɛ́nɛ́* no sandhi processes take place word-internally prior to the application of the sentence-level sandhi.

(125) a. [è-góoor ríŋ wɛ̀nɛ́]
 è-góoor ríŋ wɛ̀nɛ́
 DECL-want\1SG meat\SG\ACC here
I want some meat here.

b. [è-ŋáaal bèl wɛ̀nɛ́]
 è-ŋáaal bél wɛ̀nɛ́
 DECL-pound\1SG dura\ACC here
I am pounding dura here.

The issue of ordering of word-internal vs. word-external sandhi processes remains to be investigated through data collection of different classes of polysyllabic words in different prosodic and syntactic contexts.

In the light of the above discussion we may also wonder about the extent to which precompilation is used in Thok Reel. For example, is precompilation restricted to the objects of finite transitive verbs, or does it occur in other types of phrases? If precompilation occurs in other types of phrases such as noun phrases, we might wonder what happens when the noun that occurs in object position in a clause with a finite transitive verb is itself a head noun in a noun phrase. So far, I only have one type of such sentences in my data (126). There, the object noun is modified by an adjective. The head noun is followed by a H toned number particle, a H toned reduplication particle, and a HL toned adjective. The tone on the particles and on the adjective is stable in all contexts. Moreover, the H tone on the reduplication particle does not trigger Contour Simplification on the following adjective. There is a possibility that the number particle and the reduplication particle (and, possibly the adjective itself) are toneless and receive a default tone which does not take part in sandhi processes.

(126) [è-ŋjáaar-ì jêl mɛ́ lé-lɛ̀ŋ]
 è-ŋjáaar-ì jêl mɛ́ lé-lɛ̀ŋ
 DECL-like-2SG forest\SG\ACC SG RED-good\SG\ATTR
You like a good forest.

[è-ŋjáaar-ì gwɔ̀p mɛ́ lé-lɛ̀ŋ]
 è-ŋjáaar-ì gwɔ̀P mɛ́ lé-lɛ̀ŋ
 DECL-like-2SG skin\SG\ACC SG RED-good\SG\ATTR
You like a good skin.

[è-ŋjáaar-ì cjɛ̀ŋ tɛ́ lé-lɛ̀aaŋ]
 è-ŋjáaar-ì cjɛ̀ŋ tɛ́ lé-lɛ̀aaŋ
 DECL-like-2SG home\PL\ACC PL RED-good\PL\ATTR
You like good homes.

[è-ŋjáaar-ì gùp tɛ́ lé-lɛ̀aaŋ]
 è-ŋjáaar-ì gùP tɛ́ lé-lɛ̀aaŋ
 DECL-like-2SG skin\PL\ACC PL RED-good\PL\ATTR
You like good skins.

In possessive noun phrases, by contrast, tone on the head noun was shown to trigger sandhi processes on the genitive (see (97) and Figure 25). Unfortunately, I do not have the data where a possessive noun phrase occurs within a verb phrase with a finite transitive verb. If we assume that the precompiled phrasal allomorphs are also available for the genitive nouns, we might expect that an allomorph will be chosen on the basis of lexical or morphological tone of the head noun, and not on the basis of what allomorph of the head noun will be selected to fit this particular context (as determined by tone on the verb). On the other hand, if precompilation is restricted to nouns in object positions of finite transitive verbs, then the tone on the allomorph of the head noun will determine the application or non-application of sandhi on the following genitive. The two possibilities would give us different surface outputs, for example, in sentences with three H tones in the row: on the verb, on the object (head)

noun, and on the genitive (127). In (127a) scenario only the objects of the finite transitive verbs have precompiled phrasal allomorphs. As a result, the tone on the genitive does not undergo dissimilation. In (127b) the phrasal allomorph is chosen for the genitive on the basis of the lexical or morphological tone of the head noun, and the phrasal allomorph for the object noun is chosen on the basis of the tone on the finite transitive verb. In this scenario, both the object noun and the genitive appear [L] toned on the surface. I hope to be able to investigate this issue during my next data collection trip.

(127) a. Finite TRANS Verb . Head Noun_[Frame 1] . GEN

{H.H.H}

/H.H_[H Frame 1].H/

/H.L_[H Frame 1].H/

Dissimilatory Lowering

[H.L.H]

b. Finite TRANS Verb . Head Noun_[Frame 1] . GEN_[Frame 1]

{H.H.H}

/H.H_[H Frame 1].H_[H Frame 1]/

/H.L_[H Frame 1].L_[H Frame 1]/

Dissimilatory Lowering

[H.L.L]

In conclusion to this section, the idea of precompiled phrasal phonology is attractive for two reasons. First it allows us to avoid postulating a direct syntax-phonology

connection by allowing the allomorphs to be derived at the lexical level. Second, it allows us to account for sandhi onset and direction in sentences with different finite verbs in a unified way. However, it also raises the need to postulate some extra mechanisms to insure that once the allomorphs are placed within the sentence they are not subject to other sandhi modifications.

6.6.4. Ordering of Contour Simplification and Dissimilatory Lowering

Another point that we need to consider in the analysis of tone sandhi in Thok Reel is the order of the application of Contour Simplification and Dissimilatory Lowering. Consider example in (128). There {HL} becomes H by the application of Contour Simplification. We have seen already in (117b) that the H tone which results from the application of Contour Simplification triggers Contour Simplification and Dissimilatory Lowering on the following context. In other words, once the process of Contour Simplification turns {HL} into H it behaves as a phonological H tone. This suggests that it is also subject to Dissimilatory Lowering from the preceding H tone. However, in sentences like that in (128), once the {HL} became H, no other sandhi process apply within the resulting sequence H.H, that is H.HL → H.H and not *H.HL → H.H → H.L.

- | | | |
|-------|-----------------------------------|-----------------|
| (128) | [è-góoor ríiŋ] | *[è-góoor rìiŋ] |
| | è-góoor | rìiŋ |
| | DECL-want\3SG | meat\SG\ACC |
| | <i>He/she/it wants some meat.</i> | |

This non-application of Dissimilatory Lowering could be interpreted in two ways. One is that Dissimilatory Lowering is ordered before Contour Simplification. Another way to explain the non-application of Dissimilatory Lowering in (128) is to treat the two processes as sub-processes of a macro process which is triggered by a H tone and applies at the same time and only once between any two adjacent tones (an idea expressed in 6.6.3). In other words, once this macro process has applied, another macro process does not re-apply to the same sequence, even though the output of one sub-process (Contour Simplification) can serve as an input for another sub-process (Dissimilatory Lowering). In most contexts that I have considered so far either of the two analyses is a possibility. There is, however, a syntactic context in which an optional re-application of sandhi within one given sequence can take place. This context is significant for a number of reasons, so in the next section I will give a detailed description of all phenomena associated with it.

6.6.5. Sandhi in sentences with past tense auxiliary cĕ́

Following a H toned past tense auxiliary cĕ́ (129), both {H} and {HL} are realised as [H] (129a-b, respectively), whilst the {L} tone remains unmodified (129c). When the same words are preceded by a {L} toned past passive auxiliary càa (130), the three tonemes have a distinctive realisation – [H] in (130a), [HL] in (130b), and [L] in (130c). Figure 30 shows f₀ traces for the examples in (129-130).

(129)

- a. [è-cḗ nóoŋ] {L.H.H} → [L.H.H]
è-cḗ nóoŋ
DECL-PST\1SG bring\TRANS
I have brought him/her/it.
- b. [è-cḗ n̄jâaar] {L.H.HL} → [L.H.H]
è-cḗ n̄jâaar
DECL-PST\1SG like\TRANS
I have liked him/her/it.
- c. [è-cḗ n̄jàaam] {L.H.L} → [L.H.L]
è-cḗ n̄jàaam
DECL-PST\1SG put.in.mouth\TRANS
I have put it into my mouth.

(130)

- a. [è-càa nóoŋ] {L.L.H} → [L.L.H]
è-càa nóoŋ
DECL-PST\PASS bring\TRANS
He/she/it has been brought.
- b. [è-càa n̄jâaar] {L.L.HL} → [L.L.HL]
è-càa n̄jâaar
DECL-PST\PASS like\TRANS
He/she/it has been liked.
- c. [è-càa n̄jàaam] {L.L.L} → [L.L.L]
è-càa n̄jàaam
DECL-PST\PASS put.in.mouth\TRANS
It has been put into the mouth.

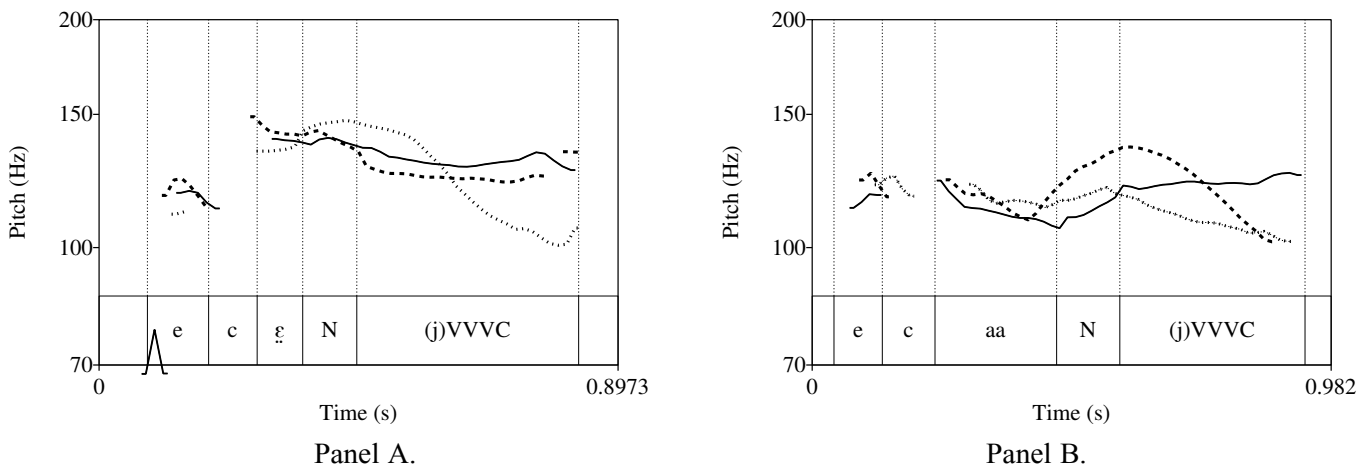


Figure 30. The three tonemes in phrase-final context after a H toned auxiliary *cê* (panel A), and after a L toned auxiliary *càa* (panel B). {H} (solid line), {L} (dotted line) and {HL} (broken line).

In panel B the target words are preceded by a {L} toned *càa*. The realisation of the three tonemes {H} – solid line, {L} – dotted line, and {HL} – broken line in panel B can be compared to the realisation of these tonemes after the {H} toned auxiliary *cê* in panel A. We can see that the three tonemes have a distinctive realisation following a L tone: {H} is realised with a somewhat rising f₀, {L} with a falling f₀, and {HL} with a rising-then-falling f₀ pattern. Following a H tone in panel A, {L} is realised with a falling f₀ trajectory. The fall is much steeper than it is in panel B due to the nature of the preceding target (high). It also sets off much later than is expected with a prototypical L – at about one-third into the glide-vowel portion. Impressionistically, this L sounds like a prototypical HL. We can see that in this context the distinction between {H} and {HL} is completely neutralised. Both are realised with a relatively high and level f₀ which is somewhat lower than that on the preceding auxiliary. F₀ remains at this high level throughout the duration of the target syllables. {HL} in this context behaves as is predicted by Contour Simplification (99): it simplifies to [H].

The {H} in this context is expected to become [L] by Dissimilatory Lowering (98), but instead we get a [H]. The question that we may ask is: is this context an exception to Dissimilatory Lowering? The answer is: it is not. We have already come across examples which show that {H} behaves as a phonological /L/ in this context (see section 6.6.2). Relevant examples are repeated in (131). We saw that the {HL} tone on the infinitive following the {H} toned noun (131a) fails to simplify (cf. 131b), which suggests that the tone on the preceding noun is /L/ at that point in the derivation. This means that the H on the auxiliary triggers Dissimilatory Lowering on the noun.

- (131) a. [è-cé gúp njâaar]
 è-cé gúp njâaar
 DECL-PST\1SG skin\PL\ACC like\TRANS
I have liked the skins.
- b. [è-cé tēet njâaar]
 è-cé tēet njâaar
 DECL-PST\1SG hand\PL\ACC like\TRANS
I have liked the hands.

Earlier I have not given the surface patterns for these examples. In fact, in both sentences in (131) the surface tone on the nouns is [H]. So, how can we explain the surface realisation of the underlying {H} in this context? Bert Remijsen (p.c.) observes that in Bor dialect of Dinka function words project tone onto the words that follow them (cf. f0 alignment for L in panel A of Figure 30). A similar process could be responsible for the neutralisation of the {H} and {HL} following cé in Thok Reel. Because the L in (131a) does not appear on the surface, I analyse this process as tone replacement. Interestingly, only the /L/ that is the output of Dissimilatory Lowering

(i.e. ex- $\{H\}$) gets replaced, whilst the underlying $\{L\}$ is not subject to tone replacement (see (132) below, and Figure 30 above). This means that the process of tone replacement must have access to the underlying representation of tone (133). The rule tells us that following the past tense auxiliary inflected for 1SG subject the /L/ that is derived from the underlying $\{H\}$ tone is replaced by a H tone.

(132) [è-cɛ̃ gət̩ n̩jâaar]
 è-cɛ̃ gət̩ n̩jâaar
 DECL-PST\1SG child\SG\ACC like\TRANS
I have liked the child.

(133) Replacement

/L/ $\{H\}$ → H / H_[AUX PST\1SG]—

There is also evidence that Dissimilatory Lowering can optionally re-apply in this context to the output of Contour Simplification. That is, an underlying $\{HL\}$ that becomes /H/ through Contour Simplification can surface as [L] (134) (cf. (131b) above). The surface realisation of the underlying $\{HL\}$ in this context (as either [H] or [L]) varies from rendition to rendition, however, this variation is only attested with nouns.

(134) [è-cɛ̃ t̩ɛ̃ɛt̩ n̩jâaar]
 è-cɛ̃ t̩ɛ̃ɛt̩ n̩jâaar
 DECL-PST\1SG hand\PL\ACC like\TRANS
I have liked the hands.

The behaviour of both $\{H\}$ and $\{HL\}$ following cɛ̃ suggests in this context we are dealing with a double application of tone sandhi. In sentences like that in (131a) and

(134) the sandhi processes start at the beginning of the utterance and apply from left to right turning {H} into /L/ and {HL} into /H/. This /H/ triggers the simplification of the following {HL} at the end of the sentence. Once these sandhi processes have taken place, some additional processes apply, again, starting at the beginning of the utterance. The /L/ (ex-{H}) becomes [H] by Replacement and the /H/ (ex-{HL}) optionally dissimilates to [L]. Since no application of Contour Simplification takes place on the infinitive following tone Replacement, I postulate that Replacement applies at the surface level. Similarly, the optional application of Dissimilatory Lowering in this context suggests that it too is a surface-level process.

The description above is summarised in (135). It shows the derivation for the three tonemes in H _ HL context where the H is the tone on the auxiliary, the HL is the tone on the infinitive, and the target syllable is the noun in object position (examples in (131), (132) and (134)). The processes listed below the horizontal line are the surface-level processes.

(135) Derivation of the sentences with H toned *cě* auxiliary.

{H.H.HL} {H.HL.HL} {H.L.HL} *underlying patterns*

/H.L.HL/ ----- ----- Dissimilatory Lowering (aux. & noun)

----- /H.H.HL/ ----- Contour Simplification (aux. & noun)

----- /H.H.H/ ----- Contour Simplification (noun & infinitive)

[H.H.HL] ----- ----- Replacement (ex-{H} only)

----- [H.L.H] ----- Dissimilatory Lowering (ex-{HL} optional)

[H.H.HL]	[H.H.H]/	[H.L.HL]	} surface pattern
	[H.L.H]		

6.7. Summary

In the section on tone I have given a description of phonetics and phonology of tone in Thok Reel. I have shown that pitch targets are aligned at the end of syllables. This is compatible with the cross-linguistic findings on the alignment of pitch targets.

We saw that there are two main sandhi processes – Dissimilatory Lowering and Contour Simplification. Both are triggered by a H tone. Dissimilatory Lowering turns a H tone into L. Contour Simplification turns HL into H. The composite nature of the contour was evident from the application of Low Deletion process by which the second (L) component of the contour gets deleted when the target syllable occurs in non-phrase-final position. I have shown that another process, tone Replacement, applies to the /L/ which originates from {H} in a restricted context (following a H tone auxiliary cĕ).

I have shown that the speakers differ with respect to rule ordering. This difference was preliminary attributed to the difference between the idiolects. Since the two speakers come from different Atuot sections (Luac and Jilek), it makes sense to conduct a quantitative study with the speakers of these two sections in the future in order to find out whether this difference is a difference between the dialects.

The observed variation in the rule ordering of Dissimilatory Lowering and Contour Simplification vs. Low Deletion for one of the speakers has lead me to distinguish between two levels of derivation: word and phrase level vs. sentence level.

I have argued that the default direction of sandhi processes in sentences is left-to-right starting at the left edge of an utterance. The apparent exception to this generalisation are the sentences with finite transitive verb where the application of sandhi first marks the juncture between the verb and its object and then proceeds from this juncture in two directions: left and right. The leftwards direction of sandhi was taken to mean which of the two adjacent tones with the reference to the juncture are being considered by sandhi processes at any given time, rather than which tone is the trigger and which is the undergoer of a sandhi process. The application of sandhi in this direction still rendered the leftmost of the two tones as a trigger and the rightmost as the undergoer of a process.

I have argued that in Thok Reel sandhi processes do not have access to the underlying tone, but only to the tone as it appears at the point of the application of sandhi, be that the lexical or morphological tone or the output of any preceding sandhi process.

The evidence from the sentences with finite transitive verbs led me to hypothesise that in such sentences sandhi is used by syntax to signal the relationship between the finite verb and its object. In attempt to avoid having to postulate a direct syntax-phonology connection I have proposed an analysis of the Thok Reel data within the framework of Precompilation theory (Hayes 1990). This framework allowed us to explain the behaviour of the tone in nouns in terms of allomorphy and to rule out the exceptional direction of sandhi in sentences with finite transitive verbs. However, this analysis was shown to require extra mechanisms to prevent sandhi from applying to the allomorphs in sentences, and we are still left with a question of how to explain serial

sandhi application within verbs. For the time being, I have left these issues unresolved.

At this stage I remain agnostic on the issue of whether the Contour Simplification and Dissimilatory Lowering are best treated as sub-processes of the same macro process (triggered by H tone) or if these processes are ordered with respect to one another.

Finally, I have argued that following a H toned past tense auxiliary *cé* sandhi applies twice. The first circle of application dissimilates the following {H} and simplifies the following {HL}. The second circle of application replaces the /L/ (ex-{H}), and optionally dissimilates the /H/ (ex-{HL}). The second circle of sandhi application was said to take place at the surface level, since the output of tone Replacement does not trigger Contour Simplification on the following context, and the application of Dissimilatory Lowering is optional.

The tone system in Thok Reel is typologically unusual in three respects. First, one of the processes that the HL toneme undergoes (Low Deletion) suggests a composite interpretation of this toneme. On the other hand, as a composite tone it is expected to undergo the same sandhi process as a H tone following another H tone (Dissimilatory Lowering). However, in this context HL does not dissimilate but becomes H (Contour Simplification). Second, whilst Thok Reel is not a tone terracing language, the sequences of H tones are realised as downwards steps, the pitch level of each H is just slightly lower than the pitch level of a previous H. Third, unless precompilation is assumed to be at work in sentences with finite transitive verbs, a syntactically

motivated sandhi that marks the juncture between the finite transitive verb and its object appears to precede the application of word-internal sandhi processes.

7. CONCLUSIONS

In this section I will give a general summary of the findings presented in this thesis and outline the directions for future research. Please refer to the sections in the main body for more detailed summaries.

I have given a descriptive analysis of the aspects of phonetics, phonology and morphophonology of a previously undocumented language Thok Reel.

The phonology of Thok Reel includes segmental and suprasegmental distinctions. In the consonantal system voiceless, voiced and nasal stops are found at five places of articulation: labial, dental, alveolar, palatal and velar (/p, t̪, t, c, k/, /b, d̪, d, ɟ, g/, /m, n̪, n, ɲ, ŋ/. In addition, a voiceless stop with a glottal place of articulation /ʔ/ occurs in onsets of syllables where it has two allophones: a stop allophone [ʔ] and an approximant-like allophone [ɦ]. The rest of the stop consonants occur in onset and coda positions of syllables. The voicing contrast is only distinctive in onset position. The other consonant phonemes are /l/, /r/, /j/ and /w/. They have the same distribution as the stops, and in addition, glides occur as the second element of the complex onsets where they combine with all consonants except for the glottal phoneme. Other consonantal clusters can occur at the morphological boundaries.

Vowels in Thok Reel come in seven qualities /i, e, ε, a, ɔ, o, u/, two voice qualities modal /V/ and breathy /V̤/, and three vowel lengths short /V/, mid /VV/, and long /VVV/. The occurrence of the modal /u/ in Thok Reel is unusual considering it is not found in Dinka and Nuer. The distribution of this phoneme in Thok Reel is restricted

to the stems of transitive verbs. This phoneme remains to be further investigated. With most vowels the modal vs. breathy opposition is signalled by energy distribution. The vowel /ɛ/ behaves differently from the rest of the breathy vowels in that it is lower and more centralised than its modal counterpart, and is fairly close to the breathy /a/.

The three tonemes H, L and HL are realised within a narrow frequency range and are mostly distinguished by f₀ alignment. The most frequently occurring realisations of the tonemes are: level or rising trajectory for H, falling trajectory for L and falling or rising-then-falling trajectory for HL. It is difficult to tell the tonemes apart in monosyllabic words uttered in isolation. The three tonemes have a distinctive realisation phrase-finally following a L tone. The H and HL are subject to sandhi modifications. The two main processes are Dissimilatory Lowering and Contour Simplification. An additional process, tone Replacement, applies to {H} that follows an auxiliary verb cɛ́. In this context it applies at the surface level together with an optional Dissimilatory Lowering that affects {HL}. The phonological status of HL can be altered in certain contexts by the application of Low Deletion. Speakers differ with respect to the ordering of the tonal processes. For one of the speakers, the ordering of the processes varies at two different levels of derivation: word and phrase level vs. sentence level.

In Thok Reel, a syntactically motivated sandhi that marks the juncture between the finite transitive verb and its object appears to precede the application of word-internal sandhi processes, and to invert the direction of sandhi. The idea of precompiled phrasal phonology appears to be attractive in the analysis of the processes in such sentences as it removes the need to refer to a syntactically-determined sandhi and to

postulate an inversion of sandhi direction. However, I have shown that relying on the precompiled phrasal phonology to explain the phenomenon at hand is not unproblematic.

The directions for future research into the tone system in Thok Reel are to conduct a quantitative study with the speakers of the Jilek and Luac sections in order to determine whether the rule ordering differences between the two speakers described here can be attributed to the dialect differences; to study the behaviour of tone in polysyllabic words in order to determine whether there are any differences in rule ordering at the word level vs. the phrase level; to test the idea of precompilation in sentences with multiple phrases (e.g. verb phrases containing noun phrases); and to determine if the two sandhi processes Dissimilatory Lowering and Contour Simplification are ordered with respect to one another in the derivation or if they apply at the same time in the derivation (e.g. a macro process triggered by a H tone).

Much of morphology in Thok Reel is signalled by means of stem-internal alterations. The two main consonantal alternations are the alternations in stem-final consonants C~j and K~w. So far, I have not found any patterns for the alternations and non-alternations in different parts of speech. The investigations into the vowel alternations were restricted to the inflectional categories of finite transitive and antipassive verbs in simple declarative sentences. The number of different voice and vowel qualities within verb paradigms varies from one to two. These alternations were characterised as vowel lowering. Vowel length alternations in Thok Reel verb inflection are more complex than the alternations attested in related languages. The alternations were characterised as vowel lengthening. The following alternations were found: V ~ VV,

V ~ VVV and VV ~ VVV. In addition, there are also paradigms with short (V), mid (VV) and long (VVV) vowels where the vowel length remains fixed. Thok Reel is typologically unusual in that all three levels of vowel length can be considered synchronically as lexical. The transitive paradigms show more complexity with respect to vowel length alternations than the antipassive paradigms, and the antipassive paradigms show more complexity with respect to voice and vowel quality alternations than the transitive paradigms.

The directions for future research will be to account for the stem-internal alternations in other word classes such as nouns and adjectives; to account for the alternations in tone that is used to mark inflection; to account for the alternations used in derivation; and to account for the inflectional classes on the basis of the combined alternations.

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