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ADVANCED TONGUE ROOT HARMONY IN SETSWANA

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(Born Mphonyo)

Thesis submitted to
the School of Graduate Studies and Research
in partial fulfillment for the M.A.
degree in Linguistics

Université d'Ottawa/University of Ottawa



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ABSTRACT

This thesis addresses certain issues in the analysis of Advanced Tongue Root [ATR] vowel harmony in Setswana, a language spoken in South Africa and Botswana. Setswana presents a particularly interesting problem as regards the analysis of harmonic patterns since there exists in the language evidence on the one hand that:

- (a) all vowels in a stem are preferentially either [+ATR] or [-ATR], but
- (b) in some cases the requirements of harmony seem to require the cooccurrence of vowels with conflicting ATR values.

The pattern of ATR harmony observed in the language presents a number of difficult problems for the adequate description of the harmonic process. These problems are outlined in the thesis.

The theoretical importance of Setswana-type harmony patterns has been established in recent work by Clements (1991) and Khabanyane (1991), examining data from Sesotho, a language closely related to Setswana and which shares the same phonetic inventory of eleven vowels and phonemic inventory of seven vowels (compare Khabanyane (1991) on Sesotho and Cole (1955) on Setswana).

In his analysis of Sesotho, Clements (1991) rejects that the process involves ATR harmony, and instead claims that there seems to exist “a fifth [open] tier” on the phonological level. According to Khabanyane, a rule of High Vowel Raising raises height 3 vowels to a new height 3a, a level between heights 3 and 4.

The hypothesis made in this thesis is that there exists a feature [\pm RTR] which is distinct from [\pm ATR]; specifically, [+RTR] is different from [-ATR]. The assumption made here is based on a proposal of Goad (1991). The inclusion of this feature solves the problem of making a distinction between the phonologically “advanced” vowels [ɪ, ʊ] and [i, u], as discussed in 2.2.3 and 2.2.4.

The analysis of ATR vowel harmony presented here will assume the general framework of Autosegmental Phonology, as proposed by Goldsmith (1976) and Clements (1980), incorporating Underspecification as proposed by Kiparsky (1982), Pulleyblank (1986a), Archangeli (1984) Archangeli and Pulleyblank (1989), etc. and Grounding Condition theory proposed by Archangeli and Pulleyblank (1994). It will be argued that grounded conditions hold of varying domains, with some conditions holding of all representations, while other conditions govern only the output of specific rules.

The first chapter provides a brief explanation of the morphological and syntactic structures of the Setswana language. A comparison is also provided to show the relation of Setswana to Sesotho.

The second chapter deals with both the phonetic and phonological analysis of vowels in Setswana, with emphasis laid on the underlying and surface representation of features and introduction of the feature RTR.

The third chapter provides the cooccurrence patterns found in Setswana, with emphasis on canonical harmony based on ATR-type harmonic patterns. In this chapter both unattested and attested forms are discussed.

The fourth chapter deals with [+ATR] lexical morphemes. These are suffixal morphemes some of which contain an underlying [+ATR] feature.

In the concluding chapter certain conclusions are made and problems which face an adequate analysis are also mentioned.

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CHAPTER ONE

1.0 Introduction

This thesis examines the nature of tongue root (“ATR”) harmony in the phonological system of Setswana. Data for the thesis is largely original, with harmony being investigated in a large number of morphological structures. The analysis is conducted within the framework of Grounded Phonology (Archangeli and Pulleyblank (1994)). Although the thesis argues that the basic patterns of Setswana are consistent with the claims of Grounded Phonology, it is demonstrated that some rather unusual patterns involving interactions between tongue height and tongue root features require rules of a type that are not typical of most published work on tongue root harmony.

1.1 Setswana language

The Setswana language consists of eight dialects, named after the group speaking the dialect. The dialects are; Sekgatla, Sengwaketse, Sengwato, Sehurutshe, Serolong, Setlharo, Sekwena and Setlhaping.

1.2 Standardisation

Standard Setswana incorporates features of all the eight dialects. A board consisting of representatives from all dialects forms the Setswana Language Board, which among other things is responsible for the standardisation of the language to be used at schools and in the literature. This board has established one standard Setswana for all the dialects. No single dialect can claim to have had a greater influence on the standard Setswana.

Cole (1955:xix) writes that:

“Considering how widely dispersed the various tribes are, it is surprising to find how uniform the language is throughout the Tswana field. Nevertheless, there are some differences in pronunciation, vocabulary and grammatical structure.”

1.3 Literature Review

The first published work on Setswana grammar was in 1838 by a missionary called James Archbell. His study was conducted on the Serolong dialect because he worked among the Barolong. Later grammarians like Livingstone (1852), Wookey (1880, 1905), Tucker (1929) and Cole (1949, 1955) among others also contributed especially to the study of the phonetics and grammar of the language. A demand for an up-to-date study of the structure of the language has existed for many years.

In this study, I have used studies conducted on Sesotho by Clements (1991) and Khabanyane (1991) as an important reference. Setswana and Sesotho are very closely related. Both languages share the same phonetic and phonemic vowel inventory¹. The same eleven phonetic vowels [i, ɪ, ʊ, e, ɛ, a, ɔ, o, ɔ̄, u, ū] and the same seven phonemic vowels /i, ɪ, e, ɔ, a, u/ are given by Doke and Mofokeng (1974) for Sesotho and by Cole (1955) for Setswana; Tucker (1969) gives the same inventory for both languages. Both languages share a number of phonological, morphological and syntactic structures as briefly illustrated in (1) (a) and (b):

¹ Compare for instance the vowel charts in Khabanyane (1991) for Sesotho and Cole (1955) for Setswana.

Although the two languages are not identical, phonological, morphological and syntactic structures differ in a manner typical of dialect divergence. While some forms may exhibit differences (compare [fepuwa] (Sesotho) and [hepiwa] (Setswana), both “to be fed”), structures are in many cases identical up to the syntactic level (SC=“subject concord”; FV=“final vowel”; REFLEX=“reflexive”; PASS=“Passive”; APPL=“applied”):

Setswana & Sesotho

- (1) a) Kgomo e i- that-el-a namane
 cow SC REFLEX like-APPL-FV calf
 ‘The cow likes its calf’
- b) Ngwana o rat-w-a ke batho
 Child SC like-PASS-FV by people
 ‘The child is liked by the people’

As will be seen in the comparison done on the work by Khabanyane (1991) and Clements (1991), harmony patterns are strikingly similar for Setswana and Sesotho. This study serves therefore to support the basic descriptive generalisations made in those studies. As a result of this similarity, phonetic and phonological evidence obtained in the study of Sesotho is directly relevant to the analysis of Setswana. In reciprocal fashion, the arguments presented here in favour of analysing Setswana harmony patterns in terms of [ATR], not in terms of the scalar height feature proposed for Sesotho (Clements 1991), suggest a possible reanalysis of Sesotho harmony.

The difference between this study and work done by both Clements and Khabanyane is that, (i) this study investigates harmony in a very large number of morphological structures as compared to the two researchers, and (ii) this study contributes new data and examines a large amount of data in a distinct, though closely related, language, finding support for the basic generalisations made in Clements’ and Khabanyane’s work.

1.4 Setswana Language Structure

The purpose of this section is to give a basic analysis of the morphological structure of the language with the aim of providing a basic set of structures within which harmony will be examined. There are two main types of morphemes in Setswana. These are the lexical and grammatical morphemes. Both morpheme types participate in harmony as triggers and are active in the harmony process. Their structure is somewhat uniform. (SG="Singular noun class prefix")

(2) Lexical Morphemes

V	-t	in	lt-t	'SG+egg'
C	n-	in	n-a	'rain+FV'
CVC	bɔn-	in	bɔn-a	'see+FV'
CV	-thɔ	in	mɔ-thɔ	'SG+person'
CVCV ²	-tlhar	in	st-tlhar	'SG+tree'

(3) Grammatical Morphemes

V	i-	in	i-pɔna	'ONESELF+see' reflexive
C	n-	in	n-tɔma	'me+bite' 1st person Object Conc.
VC	-is-	in	rat-is-a	'love+CAUSE' causative
CVCV	-nana	in	puɔ-nana	'talk+SMALL' diminutive

² Sequences like "th" and "tlh" are single consonants. That is, the digraphs and trigraphs are used to represent aspirated segments, laterals and affricates.

There are certain morphological sequences of speech sounds which are limited to certain contexts. For instance, the advanced high vowels /i/ and /u/ may not be preceded by glides as in (4) and the consonant /l/ as in (5); labials do not precede glides as in (6); consonants do not follow each other unless the first is a nasal or a liquid, and shares the same point of articulation with the succeeding one as in (7), and so forth:

(4)	y-a	'go'	/y-is-a/	isa	'go+CAUSE'
	w-a	'fall'	/w-is-a/	wɪsa	'fall+CAUSE'
	bɔlay-a	'kill'	/bɔlay-is-a/	bɔlaisa	'kill+CAUSE'
	ratw-a	'like'	/ratw-is-a/	ratisa	'like+CAUSE'
(5)	bɔl-a	'rot'	/bɔl-is-a/	bodisa ³	'rot+CAUSE'
	bɔl-a	'rot'	/stbolu/	stbodu	'something rotten'
	fɛl-a	'finish'	/fɛl-ile/	fedile	'finish+PAST'
	rɔl-a	'remove'	/rɔl-is-a/	rɔdisa	'remove+CAUSE'
	bu-l-a	'boil'	/bu-ile/	bɪdile	'boil+PAST'
(6)	lum-a	'plough'	/lum-w-a/	lungwa	'plough+PASS'
	sɛb-a	'gossip'	/sɛb-w-a/	sɛjwa	'gossip+PASS'
	bɔp-a	'built'	/bɔp-w-a/	bɔtswa	'built+PASS'
	bɔf-a	'tie'	/bɔf-w-a/	bɔswa	'tie+PASS'

³ The consonants /l/, /ts/ and /d/ are in complementary distribution, i.e. /d/ will only occur with the high vowels [i, u], while /l/ occurs with the rest of the nine phonetic vowels, i.e. [ɪ, ɪ, ɛ, e, ɔ, o, ɔ, u, a]

(7)	/mǝ-lɪɔ/	mǝ-llɔ	‘fire’
	/mǝ-nǝna/	mǝ-nna	‘man’
	/mǝ-bu/	m-mu	‘soil’
		m-pɔn-a	‘to see me’
		n-that-a	‘to love me’
		n-kgɔ-ga	‘to pull me’

The object concord for the first person singular reflexive pronoun “me” is the morpheme /n-/.

The examples above indicate redundancies which could be explained in terms of Morpheme Structure Conditions or in terms of rules. Since these restrictions do not bear directly on the patterns of vowel harmony under investigation, they will be transcribed in the data given in this thesis but will not be discussed.

1.4.1 Nominal Affixes in Setswana

The nominal affixes in Setswana signal singularity (SG) or plurality (PL). Of particular relevance for the harmonic process is the behaviour of the prefix vowels [ǝ, ɪ] during the formation of nouns from verbs. In some cases these vowels undergo harmony and in some cases they do not. This will be shown later in the study.

(8)	Class	Prefix	Noun	
	1	mǝ-	mǝ-thǝ	‘SG+person’
	1a		phǝkǝje	‘jackal’
	2	ba-	ba-thǝ	‘PL+person’
	2a	bo-	bo-phǝkǝje	‘PL+jackal’

3	m ^o -	m ^o -ts ^u	'SG+village'
4	mi-	mi-ts ^u	'PL+village'
5	li-	li-t	'SG+egg'
6	ma-	ma-t	'PL+egg'
7	si-	si-lepe	'SG+axe'
8	di-	di-lepe	'PL+axe'
9	n(t)-	n(t)-ku	'SG+sheep'
10	din-	di-nku	'PL+sheep'
11	ko-	ko-bone	'SG+lamp'
14	bo-	bo-gobe	'SG+bread'
15	go-	go-ja	'to eat'
16	fa-	fa-tsh ^u	'below'
17	go-	go-dim ^o	'on top'
18	mo-	mo-rag ^o	'behind'

There are also suffixal grammatical morphemes that are attached to nominal stems. These are -gadi and -ana/-nyana. Since these suffixes have a low vowel /a/, and therefore do not undergo harmony, their behaviour is not directly relevant to this study.

1.4.2 Verbal Affixes in Setswana

There are two types of verbal affixes, the derivational and inflectional morphemes. The derivational morphemes will derive one word category from another. The most common derivation that is relevant to ATR harmony involves the derivation of nouns from verbs. A noun prefix together with the suffix /-i/ is attached to the verb root as in (9):

(9)	Verb		Noun	
	rut-a	'teach'	mō-rut-i	'teacher'
	rək-a	'buy'	mō-rək-i	'buyer'
	lum-a	'plough'	mō-lum-i	'plougher'
	rɔbal-a	'sleep'	mō-rɔbad-i	'sleeper'
	palam-a	'climb'	mō-palam-i	'climber'

Inflectional morphemes will increase the number of items in a word category. Verbs in Setswana may be increased by suffixing verbal extension morphemes. Each morpheme entails a particular independent meaning. The inflectional morpheme will always come before the basic verbal ending vowel /-a/ as in (10):

(10)	rut-a	'to teach'	rut-an-a	'teach+RECIPROCAL'
			rut-is-a	'teach+CAUSATIVE'
			rut-el-a	'teach+APPLIED'
			rut-ɔlɔl-a	'teach+REVERSIVE'
			rut-iw-a	'teach+PASSIVE'
			rut-eg-a	'teach+NEUTER'

Note that the inflectional morphemes in (10) above do not indicate tense, aspect or modality. There are also inflectional morphemes such as the perfective affix which relate to tense, aspect and modality as in (11):

(11)	bok-a	'to praise'	bok-ile	'praise+PAST'
	om-a	'to dry'	om-ile	'dry+PAST'
	gor-a	'to leak'	gor-ile	'leak+PAST'
	sob-a	'to gossip'	seb-ile	'gossip+PAST'
	bon-a	'to see'	bon-ι	'see+PAST'
	fɔl-a	'to heal'	fots-ι	'heal+PAST'

The inflectional morphemes are highly relevant in this study because some have a [+ATR] feature as part of their underlying lexical entry while others trigger the insertion of a [+ATR] feature. Both types will be examined below.

1.4.3 The Concord

There are two types of concords in Setswana: the subject concord (henceforth SC) and the object concord (henceforth OC). With the exception of Noun Class 1, the concords are identical with the noun prefixes of the subject and/or object. The concords will always appear before the verb stem as in (12):

- (12) (a) Bana ba mo tshwer -ι (moθo)
 child-pl SC OC caught FV (person)
 'The children caught a person'
- (b) Suthari si a rwelt (maungo)
 tree SC OC bear (fruits)
 'The tree has borne fruits'

As can be observed from the examples in (12), the subject concords ‘ba’ and ‘si’ resemble the noun prefixes of the subject /ba-na/ and /si-tlharu/, and the object concords ‘mō’ and ‘a’ resemble the noun prefix of the objects /mōthō/ and /maungō/⁴.

1.4.4 The Reflexives

The reflexive pronouns may not appear in the object position in Setswana sentences; see (13a). Rather, a reflexive morpheme /i-/ is prefixed to the verb stem as in (13b):

- (13) a. *Mōthō ω bōn -a εna (mōthō)
 person SC see FV himself
 ‘A person sees himself’
- b. Mōthō ω a i- pōn -a
 person SC himself see FV
 ‘A person sees himself’

The reflexive prefix is relevant for harmony in two respects. First, it clearly demonstrates the right-to-left asymmetry of harmony: vowels to the right of a high vowel are not affected by the high vowel. Second, the reflexive seems to initiate ATR harmony in a restricted set of cases, namely in cases where deverbatives are formed from a reflexivised verb as in (14):

- (14) i-pōna ‘see oneself’
 mō-i-pōni ‘someone who sees him/herself’
 si-i-pōni ‘mirror’
 xu-i-pōna ‘to see oneself’ (noun Cl.15)

⁴ Nasal consonants are deleted during the formation of the Subject and Object concords, with the exception of the Object concord for class 1.

1.5 Theoretical Background

The analysis of Setswana vowel harmony presented in this thesis involves the interaction of four theories: Autosegmental theory, CV-tier theory, Underspecification theory, and the Grounding Condition theory. A brief outline of all four theories will be given in this section.

1.5.1 Autosegmental theory

Since pioneering work by Goldsmith (1976) and Clements (1980), autosegmental theory has been widely used in the analysis of phonological phenomena such as vowel harmony. The crucial aspects of autosegmental phonology that play a role in the study here are the following: that a harmonic feature is assigned to an independent autosegmental tier, and that rules and/or conventions assign the harmonic feature to the class of harmonic elements.

In general, an autosegmental feature may be underlyingly linked, as in (15a), or underlyingly free, as in (15b). For Setswana, the harmonic specification of [ATR] is underlyingly linked to high vowels [i, u], and in a special class of morphemes, it may be the case that [ATR] is underlyingly floating.

(15) a. +ATR b. +ATR
 | |
 V V

These claims are motivated in section 3.1 and in chapter 4.

1.5.2 CV-tier theory

The focus of the work on harmony presented here is vowels; consonants do not play a significant role. A variety of proposals for consonant and vowel representation would

This proposal concerning [+ATR] results in two distinct sets of high vowels being specified as [+ATR], that is, [i, u] vs. [ɪ, ʊ]. The manner in which these sets are distinguished is by invoking an additional feature, [±RTR]. This is the focus of section 2.2.3.

1.5.4 Grounding Condition theory

I explore in this thesis the proposal made by Archangeli and Pulleyblank (1994) that substantive conditions are narrowly constrained by “Grounding Condition Theory”. The basic proposal here is that there is a constrained interaction between features such as those that govern tongue body movement and those that govern tongue root movement. When the tongue body is raised to produce high vowels, the tongue root is typically advanced, giving as a result a [+high] [+ATR] vowel (High/ATR). When the tongue body is lowered, the tongue root is typically unadvanced, resulting in the production of a [+low] [-ATR] vowel (Low/ATR).

Such conditions play a significant role in Setswana. Specifically, it is proposed in this thesis that the insertion of [+ATR] in Setswana requires the presence of the feature [+high] and that [+ATR] may only be linked underlyingly to high vowels.

- (18) (a) ATR/High: If [+ATR] then [+High] and not [-High]
 (b) High/ATR: If [+High] then [+ATR] and not [-ATR]

While it is argued that such conditions are important for understanding Setswana harmony, they are not surface-true generalisations. For example, there are mid advanced vowels in derived contexts, exceptions to ATR/High, and there are high retracted vowels, exceptions to High/ATR. Such violations of these conditions are discussed below; refer for example

to the discussion on the past tense suffix in 4.6, where the feature seems to be associated underlyingly to the mid vowels [e, o].

In other cases, however, it appears that a grounded condition may invariably be respected in Setswana. It is argued in this thesis, for example, that the phonological representation of Setswana is generally constrained by the conditions in (19) on the cooccurrence of lowness with tongue root movement.

- (19) (a) Low/ATR: If [+Low] then [-ATR] and not [+ATR]
 (b) ATR/Low: If [+ATR] then [-Low] and not [+Low]

The role of such grounded conditions, and the differences in their scope will be examined in some detail in this thesis.

Note also that although in certain cases Setswana appears to clearly support the basic tenets of Grounding theory, in other cases it appears to pose rather interesting problems. For example, since [+ATR] is preferentially assigned to high vowels, why is it the case that ATR Insertion targets mid vowels [e, o] and not high vowels [i, u]? A solution to this problem will be proposed in section 3.2.

1.6 Summary

This chapter has outlined relevant aspects of the morphological structure of Setswana, and identified the different morphemes to be treated in the study. A brief explanation of possible theories that can account for the analysis of ATR harmony in Setswana. The following chapter concentrates on the analysis of the phonetic and phonological properties of vowels in the language.

CHAPTER TWO

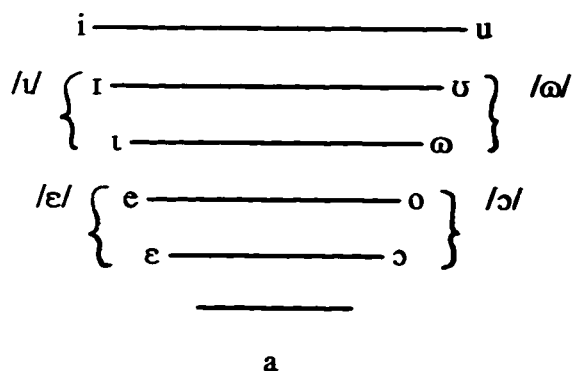
2.0 SETSWANA VOWELS

A phonetic and phonological analysis of Setswana vowels is presented in this chapter. The focus is on the analysis of vowels in isolation, identification of vowels that occur uniquely in harmonic contexts, and on the featural specification of all vowels attested.

2.1 Phonetic analysis of Setswana vowels

As seen in chapter one, Setswana has eleven phonetic vowels (Cole 1949) [i, ɪ, ɪ̄, e, ɛ, a, ɔ, o, ɔ̄, u, ū]. Figure 20 shows these eleven vowels with their positions plotted on a vowel chart. Vowels belonging to the same phoneme, on the basis of vowel alternations to be seen below, are bracketed together.

(20) Setswana vowel chart



Vowel alternations establish that the vowels [e, o] are the advanced alternants of [ɛ, ɔ] and that [ɪ, u] are the advanced alternants of [ɪ̄, ɔ̄]. Such pairings can be used to confirm the ATR-ness of the eleven Setswana vowels. Consider data such as in (21) and (22):

(21)	lm-a	'plough'	lm-is-a	'plough+CAUSE' (make to plough)
			lm-ile	'plough+PAST' (ploughed)
			lm-iw-a	'plough+PASS' (be ploughed)
	rom-a	'send'	rom-is-a	'send+CAUSE' (make to send)
			rom-ile	'send+PAST' (sent)
			rom-iw-a	'send+PASS' (be send)
	rek-a	'buy'	rek-is-a	'buy+CAUSE' (make to buy)
			rek-ile	'buy+PAST' (bought)
			rek-iw-a	'buy+PASS' (be bought)
	fɔl-a	'heal'	fod-is-a	'heal+CAUSE' (cause to heal)
			fod-ile	'heal+PAST' (healed)
		/fɔl-iw-a/	fod-is-iw-a	'heal+PASS' (be healed)
(22)	/n(ɪ)-	kɛtsi/ ⁵	kɛtsi	'bag'
	/n(ɪ)-	metsi/	metsi	'water'
	/n(ɪ)-	kɔdu/	kodu	'deep voice'
	/n(ɪ)-	kɔpi/	kopi	'cup'
	/lɪ-	fifi/	lɪ-fifi	'SG+darkness'
	/lɪ-	itlhɔ/	lɪ-itlhɔ	'SG+an eye'
	/mɔ-	ru/	mɔ-ru	'SG+bush'
	/mɔ-	dupɔ/	mɔ-dupɔ	'SG+bad smell'

⁵ The noun class prefix for class 9 is n(ɪ)-, and is only attached to monosyllabic noun stems e.g. n-ku 'sheep'; n-kɔ 'nose', etc. The prefix vowel /ɪ/ is only observed as an agreement morpheme i.e. as subject concord.

The data in (21) show that [e, o, ɪ, u], stem vowels in the second column, are the advanced counterparts of [ɛ, ɔ, ɪ, ɔ], stem vowels in the first column. In Cole's (1949) view, the vowels [e, o, ɪ, u] are closer variants of the normal phonemes /ɛ, ɔ, ɪ, ɔ/. In the cases in (21), harmony is triggered by the high advanced vowel [i] found in each suffix of the second column. The data in (22) show that only the advanced set of vowels occur before [i] in stems, and illustrate cases where harmony affects a prefix.

This chapter is concerned with the representations derived by harmony, not with the actual mechanisms of harmony nor with the precise distribution of advanced and retracted forms (for which, see chapter 3). The issue at present is to assign appropriate representations to the eleven vowels found phonetically in Setswana.

From the above data, it can be seen that there is a single vowel, [a], that can be plausibly considered "low". Four vowels straightforwardly fall into the "mid" class, namely [e, ɛ, o, ɔ]: of these four, two are back and rounded, [ɔ, o], and two are front and unrounded [e, ɛ]. A problem, however, arises with the class of high vowels. As seen in (20), there appear to be three high vowels of both the front unrounded [i, ɪ, ɪ] and back rounded [u, u, ɔ] types. Since the three vowels of each set agree for height, backness and rounding, the problem is to find a way of representing the distinction between the three segments of each set.

Although examples such as those in (21) support the argument that [ɪ, u] are the advanced counterparts of [ɪ, ɔ], it must be noted that [ɪ, u] are phonetically distinct from the high advanced vowels [i, u].

Two points arise in this connection, the first phonetic, the second phonological. The first issue is to establish that the putative distinction between [i, u] (vowels that are

underlyingly advanced) and [ɪ, ʊ] (vowels that are advanced as a result of harmony) is a real distinction. If this can be adequately established, then the phonological task is to find a featural representation for the three-way distinction that results.

First, the phonetic realisation of the vowels [ɪ, ʊ] can be established to be distinct from the realisation of the vowels [i, u] on the basis of perception and native speaker intuitions.

Further evidence for the phonetic distinction can be observed from the acoustic analysis of Sesotho vowels by Khabanyane (1991). As mentioned earlier in the thesis, Sesotho exhibits exactly the same kind of vowel inventory as Setswana. Therefore to establish the existence phonetically of [i, ɪ, ʊ] and [u, ʊ, ɔ] series in Sesotho would support the positing of comparable sets in Setswana.

In Khabanyane's analysis of formant frequencies for the eleven phonetic vowels of Sesotho, the following values for the tongue height (F1); tongue frontness (F2); lip rounding (F3) and pitch measurement (F0) were observed for the six high vowels:

(23)	Speaker	[i]	[ɪ]	[ʊ]	[ɔ]	[u]	[ʊ]
F1	A	276	319	385	393	322	255
	B	283	302	422	465	346	261
F2	A	2264	2168	2426	928	1295	1016
	B	2282	2390	2413	1309	1591	1096
F3	A	3092	2797	3284	2779	2609	2703
	B	3170	3237	3056	3464	3197	2741
F0	A	219	198	202	199	200	210
	B	198	217	206	204	221	210

These formant values may be interpreted as follows; a distinction between the six high vowels can be done with reference to, firstly, three height levels, since as can be observed

these vowels give different F1 formant frequencies; secondly, it is then argued that there is phonetic evidence for a difference with regard to F2, frontness and backness, which involves the forward and backward movement of the tongue during the articulation of these high vowels; and lastly the formants also show a distinction between lip rounding.

It is argued in this thesis, that [ɪ] and [ʊ] do not occur underlyingly. That is, while [i, u] and [ɪ, ʊ] contrast lexically, [ɪ] and [ʊ] are derived from the phonemes [i] and [u] respectively via ATR harmony. This creates a problem, however. Since all six vowels are high, [i, ɪ, u, ʊ] being advanced and [ɪ, ʊ] being retracted, how is a distinction to be made between [i, u] and [ɪ, ʊ]?

An answer is suggested in a proposal by Goad (1991, 1993) to recognise two distinct tongue root features. Goad proposed that there are two independent tongue root features, one for advancement, [\pm ATR], and one for retraction, [\pm RTR]. Importantly, she argues that “[−ATR]” is not the same as “[+RTR]”. Although she suggests that [\pm RTR] is primarily or exclusively a consonantal feature, evidence from Setswana suggests that the featural distinction is needed within the class of vowels. While not arguing for the use of both features in a single language, Leitch (1996) also makes the case for vocalic use of the feature [RTR].

Given two tongue root features, the vowels [ɪ, ʊ] can be analysed as compromise values for vowels phonologically assigned both advancement and retraction. One possibility is to assume that [i, u] are [+ATR, −RTR], [ɪ, ʊ] are [−ATR, +RTR] and [ɪ, ʊ] are [+ATR, +RTR].

A variant of this approach is to analyze the intermediate vowels [ɪ, ʊ] as [−ATR, −RTR]. This analysis still requires a [+ATR, +RTR] stage, however, since it is the assignment of

[+ATR] to the [+RTR] vowels [ɪ, ɔ] that produces [ɪ, u]. This proposal will be elaborated below. The crucial point is that by adopting Goad's proposal for two tongue root features, it is possible to derive the three-way distinction observed in Setswana.

2.2 Phonological analysis of Setswana vowels

The aims of this section are (i) to work through the contrastive vowels of Setswana, motivating the set of feature specifications as in (24); (ii) to show redundancies and cooccurrence restrictions (hi/lo, low/bk, low/ATR, etc.) and (iii) to identify the problematic specification of derived advanced vowels.

(24) (a) F-elements: +HI +LO +BK +ATR +RTR

(b)		i	[ɪ]	ɪ	[e]	ɛ	a	ɔ	[o]	ɔ	[u]	u
	High	+	+	+						+	+	+
	Low						+					
	Back							+	+	+	+	+
	ATR	+	[+]		[+]				[+]		[+]	+
	RTR		+	+						+	+	

Note that the specifications [+ATR, +RTR] are ultimately converted to [-ATR, -RTR], as discussed in 2.2.3.

2.2.1 The feature High

As explained above there are six high vowels on the surface in Setswana, three front vowels [i, ɪ, ɪ] and three back vowels [u, ɔ, ɔ]. These high vowels may be observed in words such as those in (25):

(25)	(a)	[i]	in-a	‘dip’	[u]	bul-a	‘open’
			pina	‘song’		dul-a	‘sit’
			dir-a	‘work’		pula	‘rain’
			bin-a	‘sing’		maru	‘clouds’
	(b)	[ɪ]	li-ina	‘name’	[ʊ]	mu-dupɔ	‘smell’
			lim-ile	‘plough+PAST’		ruk-ile	‘sow+PAST’
			sig-ile	‘cut+PAST’		god-ile	‘grow+PAST’
			brd-isa	‘boil+CAUSE’		lum-isa	‘bite+CAUSE’
	(c)	[ɪ]	li-rakɔ	‘wall’	[ɔ]	mɔjakɔ	‘door’
			lum-a	‘plough’		rɔk-a	‘sow’
			sig-a	‘cut’		gɔl-a	‘grow’
			bul-a	‘boil’		lom-a	‘bite’

It is argued in this study that the forms given in (25a) and (25c) occur in unconditioned environments, while those in (25b) occur only to the left of a vowel that is underlyingly high and advanced (i.e. [i, u]).

It is further assumed that the articulatory properties of these high vowels seem not to involve any significant change in the tongue height. There seems to be little difference in the highest point of the tongue body during the articulation of all high vowels [i, ɪ, ɪ, ɔ, u, u] as already stated in 2.1 above, a claim also supported by Cole’s (1949) analysis of Setswana.

I assume that the feature [+High] is the active feature in Setswana, and that it plays an important role actively in the phonology (to be discussed in chapters 3 & 4).

- i. high vowels are the only vowels that bear [+ATR] underlyingly (except for the few mid vowel exceptions discussed in section 3.2)
- ii. high vowels condition the insertion of [+ATR] to their left as shown in 3.4.

The special relation between [+high] and [+ATR] is attributed to the grounding conditions ATR/High, High/ATR (Archangeli and Pulleyblank (1994)). It will be suggested later that this condition, although not absolute, plays a role in both rules and representations.

2.2.2 The feature Low

There is only one low vowel [a] in Setswana as explained in 2.1 above. This vowel does not generally undergo vowel harmony (though note section 3.4) and will then block ATR harmony from being spread onto nonlow vowels across it. I assume that the vowel [a] is underlyingly specified as [+Low] and that all other vowels will receive their [-Low] specification through the application of a redundancy rule. According to Kaye et al (1985), as cited by Pulleyblank, there is a universal constraint at the phonetic level, which states that “no phonetically low vowel can be [+ATR]” (Pulleyblank 1986b:136). Whether or not advanced low vowels are absolutely ruled out, their occurrence is highly marked.

This notion is encoded in the Grounding Condition theory, as discussed above. Therefore the Grounding Conditions ATR/Low, Low/ATR will account for the behaviour of the low vowel [a]: the [+ATR] feature may not be linked or spread to a [+Low] vowel. The low vowel [a] is thus said to be opaque.

(26)	m̩-jak-i	‘foreigner’
	ma-ru	‘clouds’
	tshadi	‘women’

sukam-is-a		'turn+CAUSE'
sukam-ed-is-a		'turn+APPLIED+CAUSE'
kotam-is-a		'squat+CAUSE'
bola-ile		'kill+PAST'
tsama-ile		'walk+PAST'
rapel-ets-t	/rapel-el-t/	'pray+APPLIED+PAST'
gatel-ets-t	/gatel-el-t/	'force+APPLIED+PAST'

2.2.3 The tongue root features

It is argued in this study that the basic form of nonhigh vowels is retracted when in isolation, becoming advanced in special contexts where [+ATR] is assigned by rules of spreading or insertion.

It has been seen in data such as (21) and (22) that [ɪ, ɔ, e, ɔ] alternate with [i, u, e, o] when followed by [i, u]. The vowels [i, u], on the other hand, do not alternate but surface consistently as advanced. Such evidence argues that the active value for [±ATR] is [+ATR], and that [i, u] are defined by the underlying linking of [+ATR]. Were [±RTR] to be considered an active harmonic feature, it would nevertheless be crucial to assign [+ATR] to [i, u] to distinguish them from [ɪ, ɔ], suggesting that the crucial feature for high advanced vowels is indeed the value for [+ATR], not [-RTR]. The analysis of Setswana as involving [+ATR] harmony is consistent with the apparently unmarked pattern cross-linguistically (Kaye et al (1985), Archangeli and Pulleyblank (1994)).

Even if an analysis of [i, u] as underlyingly [+ATR] is accepted, one must establish in addition the underlying representation of [ɪ, ɔ] as well as the surface representation of [ɪ, ɔ] and [i, u]. Various options are considered here.

The first possibility considered is that of representing only [+ATR] underlyingly.

(27) [+ATR] vs. \emptyset possibility

Underlying ATR	[i][u] +	[ɪ][ʊ]	
Derived ATR	[i][u] +	[ɪ][ʊ]	[ɪ][ʊ] +

The table above shows the class of posited forms, indicating no distinction between [i][u] and [ɪ][ʊ] since both vowels are [+ATR], [i, u] underlyingly and [ɪ, ʊ] as a result of harmony. Note that the vowels [ɪ, ʊ] are derived by ATR harmony only; they do not occur in the underlying inventory. The [+ATR] vs. \emptyset representation fails because it wrongly neutralises the distinction between [i, u] and [ɪ, ʊ].

One might imagine a second underlying possibility, namely, to specify [-ATR] rather than [+ATR] underlyingly.

(28) [-ATR] vs. \emptyset possibility

Underlying ATR	[i][u]	[ɪ][ʊ] -	
Derived ATR	[i][u]	[ɪ][ʊ] -	[ɪ][ʊ]

Assimilation in the above table would have to be by delinking rather than spreading; in any event according to this approach (like the previous one), there is no distinction between [i][u] and [ɪ][ʊ]. The failure to make this distinction is a crucial defect in the [-ATR] vs. \emptyset hypothesis since [ɪ, ʊ] are phonetically distinct from [i, u].

A third possibility would be to represent both [+ATR] and [-ATR] underlyingly.

(29) [+ATR] vs. [-ATR] possibility

Underlying ATR	[i][u] +	[ɪ][ɔ] -	
Derived ATR	[i][u] +	[ɪ][ɔ] -	[ɪ][ʊ] +/-

According to this approach, one must crucially assume that prior to the application of harmony, both values of [\pm ATR] are present. That is, if radical underspecification is assumed, then the redundant assignment of [-ATR] must take place prior to harmony. Once harmony spreads [+ATR], a rather unusual, perhaps unprecedented interpretation of binary features would be required, namely, that both “+” and “-” values can occur on a single vowel, producing a phonetic result that is intermediate between the two extremes indicated by “+” and “-”. Presumably one would not want the same freedom of interpretation to be available for features like [nasal], [continuant], [voiced], etc.

I conclude, therefore, that no single feature is sufficient to account for the Setswana patterns. Extending a proposal in Goad (1991), I therefore analyze Setswana harmony as involving two features, one for tongue root advancement [\pm ATR] and one for tongue root retraction [\pm RTR]. Given these two features, [i, u] can be underlyingly [+ATR], and [ɪ, ɔ] can be underlyingly [+RTR]. When harmony assigns [+ATR] to underlying [ɪ, ɔ] the result is a combination of values that is illformed phonologically because of the combination [+ATR, +RTR]. This combination is converted to [-ATR, -RTR] by the negation process to be discussed immediately.

(30) ATR & RTR possibility

Underlying	[i][u]	[ɪ][ɔ]	
ATR	+ATR		
RTR		+RTR	
Derived by harmony	[i][u]	[ɪ][ɔ]	[ɪ][ʊ]
ATR	+ATR		+ATR
RTR		+RTR	+RTR
Final	[i][u]	[ɪ][ɔ]	[ɪ][ʊ]
ATR	+ATR	-ATR	-ATR
RTR	-RTR	+RTR	-RTR

This possibility is like the last one in its effects, but is not subject to the same conceptual difficulties since the advancement and retraction values are now interpreted as two distinct features. Like the last approach, it presents the problem of redundancy: [+RTR] must be present prior to harmony to keep the distinction between [i, u] and [ɪ, ɔ] from being neutralised.

Two points are relevant before leaving this basic discussion of feature representations. First, two tongue root features, rather than just one, can be motivated phonetically if one refers to a description such as that in Hall and Hall (1980). Hall and Hall describe tongue root oppositions in different languages as involving a choice between (i) advanced tongue root vs. retracted tongue root, (ii) advanced tongue root vs. neutral tongue root, or (iii) neutral tongue root vs. retracted tongue root. My proposal for Setswana is that the language exploits this space maximally, opposing (i) advanced tongue root from (ii) neutral tongue root from (iii) retracted tongue root.

A second point is that it is more natural to characterise the intermediate vowels as [-ATR, -RTR], rather than [+ATR, +RTR]. Such a result is possible if we invoke a proposal by Calabrese (1988, 1995). Calabrese examines a class of phenomena where the operation of

a phonological rule produces illicit or marked feature combinations. He proposes a set of “simplification procedures” which repair disallowed configurations that are too complex. Calabrese observes:

“The function of the simplification procedures is not to preserve the underlying inventory of segments by eliminating all disallowed feature configurations, but to prevent an increase in the complexity of a phonological system by repairing complex feature configurations”.

Calabrese proposes simplification operations of fission, delinking and negation. Of relevance for Setswana, the procedure of “negation” reverses the values of two conflicting feature values. In the case in question, because of the presumably grounded condition prohibiting the cooccurrence of [+ATR] and [+RTR] (ATR/RTR: If [+ATR] then [-RTR] not [+RTR]), any rule that brings about the combination [+ATR, +RTR] can be assumed to invoke negation, giving the result [-ATR, -RTR]. Hence the ultimate surface representation of Setswana high vowels is: [i, u] [+ATR, -RTR]; [ɪ, ʊ] [-ATR, -RTR]; [ɪ, ʊ] [-ATR, +RTR]. I assume that Setswana specifies in its grammar that the operation of negation is invoked automatically, whenever the sequence [+ATR, +RTR] is derived by a rule.

It is therefore argued that the distinction between the two sets of [+ATR] vowels [i, u] and [ɪ, ʊ] can be accounted for by introducing the feature [+RTR] in the phonology. Note that the vowels [ɪ, ʊ] may not occur as phonemes. The full range of possible vowels can be seen in the data in (31):

- (31) a. /mᵱ-bila/ mmila ‘street’
 /mᵱ-mula/ mmula ‘malt’
 /mᵱ-bula/ mmula ‘cut someone’
 /mᵱ-bela/ mmela ‘put away for someone’
 /mᵱ-bᵱna/ mmᵱna ‘see someone’
 /mᵱ-bᵱtsa/ mmᵱtsa ‘ask someone’
 /mᵱ-bala/ mmala ‘colour’
- b. * /mmula/
 * /mmula/

It is argued in section 3.2 that only high vowels show phonological evidence of being [+RTR]. As concerns the values [−ATR] and [−RTR], I assume that [−ATR] and [−RTR] are either features of phonetic implementation (Keating (1988), Pierrehumbert and Beckman (1988)), or default values assigned fairly late in the derivation. That is, once ATR harmony has occurred, all vowels not changed during ATR harmony will surface as [−ATR], [−RTR] as in (32): (NP=noun class prefix; , FV= final vowel)

- (32) mᵱ-tlhatledi ‘CP+lecturer’
 ngodieg-a ‘tempted+FV’
 etsis-a ‘imitate+FV’
 mᵱ-rekuludi ‘CP+saver’
 st-apei ‘CP+cook’

2.2.4 An alternative to [ATR] and [RTR]

For Sesotho, and by extension for Setswana, Clements (1991) proposes an alternative to analysing the distinction between [i, u], [ɪ, ʊ] and [ɪ, ʊ] in terms of tongue root features.

According to Clements, the vowels in Sesotho are “represented in terms of the binary feature [open]”. His analysis rejects the claim that phonological theory includes a finite number of vowel heights, positing instead a potentially infinite number of possible vowel heights. Clements states that this is because:

“If High Vowel Raising is a true phonological rule involving phonological features, it is clear that no possible combination of the standard feature [high], [low], and [tense]/[ATR] can give a straightforward account of the height 3a vowels. In contrast, the hierarchical model can account for them by allowing [open] to occur on a fifth tier, as follows.”

Clements’ model can analyse Sesotho and Setswana vowels as follows:

(33) Sesotho surface vowels⁶:

height:	4	3a	3	2a	2	1
	i ʊ	i ʊ	i u	e ɔ	e o	a
open ₁	-	-	-	-	-	+
open ₂	-	-	-	+	+	+
open ₃	-	+	+	+	+	+
open ₄	-	-	-	-	+	+
open ₅	-	-	+	+	+	+

Given these specifications, two rules account for the patterns of harmony seen in Setswana (to be examined in the next chapter). One rule, High Vowel Raising, spreads “the feature

⁶ Clements’ vowels are represented as follows in this study; [i, ʊ] as [i, u]; [i, ʊ] as [ɪ, ʊ]; [i, u] as [ɪ, ʊ]; [e, ɔ] as [e, o] and [e, o] as [e, ɔ] respectively.

[-open₅] from height 4 vowels to height 3 vowels,” changing [i, u] ([ɪ, ʊ]) to [i̠, u̠] ([ɪ̠, ʊ̠]). The second rule, Mid Vowel Raising, spreads the feature [-open₄], changing [e, o] ([e, ɔ]) to [e̠, ɔ̠] ([e̠, ɔ̠]). Clements discusses both rules in detail, and shows that they cannot be collapsed into a single rule. That adequate rules can be formulated within the rich set of vowel heights postulated by Clements is clear; what is at issue is whether such multiple heights are really necessary.

Note that one common point between Clements’ analysis and the proposed analysis is that there is a very subtle difference between vowels [i, u] and [ɪ, ʊ], a difference that occurs in derived contexts but not underlyingly. As can be observed in Khabanyane (1991), the acoustic measurements show mean first formant differences between the corresponding vowels [i, u] and [ɪ, ʊ] ranging between 20 and 80 Hz. What seems to be the problem however, is the feature that accounts for the difference.

A significant problem for Clements’ approach is its lack of restrictiveness. Allowing five binary [+open] features ([±open₁] , [±open₂] [±open₅]) predicts the possibility of 2⁵ possible vowel heights, that is, 32 distinctive vowel heights. While this approach can capture the relations between the six vowel “heights” of Setswana and Sesotho, it could also capture numerous other imaginable relations. Why, for example, is the distinction between series 2 and 2a in (33) accomplished by [open₅] instead of [open₄] or [open₃]? Note, moreover, that neither plus nor minus values of [open] imply corresponding plus or minus values on other [open] tiers. For example, [+open₃] is a possible value for a vowel that is either [+open₂] or [-open₂] and either [+open₄] or [-open₄]; similarly, [-open₄] is a possible value for vowels that are either [+open₃] or [-open₃] and either [+open₅] or [-open₅]. This point can be seen clearly in the various example languages of Clements (1991).

While Clements argues for a [-open₅] feature, this thesis proposes that a tongue root feature [RTR] can account for the difference between high vowels. As such, harmony involves the spreading of the [+ATR] feature to a [-ATR] vowel as in (34) below:

- (34) (a) +ATR Linked
 |
 V C V
 /ɪ, ʊ/ [i, u]
- (b) +ATR Spread
 |
 V C V
 [ɪ, ʊ] [i, u]

Under this account, far fewer vowel heights are possible. The features [±high] and [±low] define three basic heights, and the features [±ATR] and [±RTR] define a maximum of three subheights for a total of nine. This is considerably less than the 32 predicted by Clements' (1991). Note moreover that Clements' theory allows for even more height distinctions, as [open₅], etc. would be possible. In contrast, the approach using [High], [Low], [ATR], [RTR] predicts even fewer distinctions than nine in the unmarked case. This is because the cooccurrence of both [-ATR] and [+RTR] are marked with [+High] and the cooccurrence of [+ATR] and [-RTR] are marked with [+Low]. Hence adoption of a second tongue root feature is a much more conservative move theoretically than the adoption of an unbounded set of [open] features.

Note with regard to mid vowel raising, the change of [e, ɔ] to [e, o], the analysis of Khabanyane (1991:31).

She states that:

“In Southern Sotho, a process of partial height assimilation takes place when certain vowels are followed in the word by higher vowels. In other words, vowels of lower height shift towards vowels of higher heights. This does not, however result in complete assimilation because lower vowels do not change completely to the height of the sounds that influence them.”

Most advanced mid vowels are straightforwardly derived by the sort of raising described by Khabanyane; some examples have already been seen, e.g. (21). Certain cases of advanced mid vowels are problematic, however, because the advancement on the mid vowel seems to have no source. Cases where apparently underived advanced mid vowels occur in Sesotho are provided by Khabanyane; in (35), similar data are provided from Setswana.

(35)	/e/	betla	‘mould’	/o/	konyana	‘sheep+DIM’
		besa	‘make fire’		boro	‘boar’
		telele	‘long/tall’		fosa	‘miss’
		benya	‘shine’		gotsa	‘to light’
		fenya	‘defeat’			

The observation made in this study is that the advanced mid vowels [e, o] do not occur except in harmonic contexts, although a restricted number of forms seem to violate this generalisation. That is, in a small number of cases, these vowels occur even when not derived via harmony. Given the rarity of the underived cases, two possible analyses can be made to account for these cases:

- (i) a possibility that these vowels involve exceptional pre-linking of [+ATR] to mid vowels, as in (36):

(36) +ATR
 |
 C V C - V
 mid

- (ii) a possible derivation via the application of the spreading rule in (34); this analysis would require postulating the presence of [+ATR] values on the consonants [tɪ, ts, s, ny], to account for cases such as those in (35).

The latter hypothesis, however, raises some interesting questions. Firstly, why would some consonants underlyingly be specified for [+ATR] (if indeed such analysis is warranted)? Secondly, why is it precisely the set of consonants [tɪ, ts, n, s] that has this property? Lastly, if these consonants do have an active [+ATR] feature, then why would they target the vowels [e, o] and not [ɪ, ʊ]? Evidence for the latter point can be seen in (37):

(37)	*munyɔ	*sɪ-tɔɔɔ	*brtsa
	*buna	*mʊ-tɪlpa	*lɪsa
	*lɪ-nyɔra	*butsa	*busa

Khabanyane further claims that /ɛ, ɔ/ and /e, o/ are separate phonemes and that it is not always the case that [e, o] are derived from /ɛ, ɔ/. Contrary to her claim, this thesis expresses the idea that the vowels [e, o] are derived via [+ATR] harmony, either through a process of spreading an [+ATR] feature from a specified vowel, such as /i, u/ or from inserting a [+ATR] feature on an unspecified mid vowel /ɛ, ɔ/ (see chapter 3). Finally in a small residue of cases, it is assumed that [+ATR] is underlyingly linked to a mid vowel or that such morphemes have an exceptional specification of a floating [+ATR] (see below).

Note that cases where [+ATR] is underlyingly linked to a mid vowel raise interesting questions about the status of the grounding condition ATR/High (If [+ATR] then [+high]). The ATR/High condition is not inviolable since there are mid advanced vowels. Hence the condition describes a tendency, not an absolute requirement. Note, however, that high advanced vowels are frequent in the lexicon while mid advanced vowels are rare (unless derived by harmony), and low advanced vowels are completely unattested. For similar cases, see Archangeli and Pulleyblank (1994) on Akan and Pulaar. In addition, many of the instances of advanced mid vowels are found in grammatical morphemes (e.g. the past tense suffix *-ile* and the demonstratives). Finally, [+ATR] is only inserted before a high vowel, and generally spreads from a source that is high. These points will be illustrated in the next chapter.

2.3 Summary

This chapter has shown both the phonetic and phonological properties of Setswana vowels, indicating the feature specifications for these vowels. It is assumed that the set of underlying specifications for both the underlying (34a) and derived (34b) set of vowels, must include the feature RTR, and may be as given in (38):

(38) (a) Underlying F-elements: +HI +LO +ATR +RTR +BK

	i	ɪ	ɛ	a	ɔ	ɒ	u
High	+	+				+	+
Low				+			
Back					+	+	+
ATR	+						+
RTR		+				+	

(b) Surface representations

	i	ɪ	ɪ	e	ɛ	a	ɔ	o	ɔ	ʊ	u
High	+	+	+	-	-	-	-	-	+	+	+
Low	-	-	-	-	-	+	-	-	-	-	-
Back	-	-	-	-	-	+	+	+	+	+	+
ATR	+	-	-	+	-	-	-	+	-	-	+
RTR	-	-	+	-	-	-	-	-	+	-	-

From the table above one observes the distinction between the high vowels clearly. The underlying specifications given above will be discussed in chapter 3.

CHAPTER THREE

3.0 The basic cooccurrence patterns of vowels

The aim of this chapter is to examine the phonological properties of vowel harmony and to propose an analysis based in grounded properties of [ATR]. It is shown that an analysis of Setswana is possible without recourse to the unbounded set of [open] features proposed by Clements (1991).

The following claims are made in Clements' analysis;

- Firstly, that the mid vowels [e, o] may exist underlyingly, and may trigger 'Mid Vowel Raising'. It is argued in this thesis that such cases involve exceptional cases of [ATR] pre-linked to mid vowels or floating [+ATR] specifications: see 3.1.
- Secondly, that the high vowels [ɪ, ɔ] will also target mid vowels and raise them to a higher level. It is argued that such occurrences are accounted for by the application of an Insertion rule as explained below.
- Thirdly, Clements rejects the system of pairing different vowels into overlapping sets as in Akan. As will be shown in this chapter, vowels in Setswana can be grouped into two sets of ATR-type harmony. The data in (31, 38, 41) support the assumption made in this study, that the [+ATR] vowels [ɪ, e, o, u] are derived from [ɪ, e, ɔ, ɔ] via the [ATR] spread rule given in (44).

As outlined in the last chapter, the proposal made here is that the underlying specification of [ATR] and [RTR] for vowels in Setswana may be as in (39). Note that [+RTR] could either be present underlyingly, or assigned by a redundancy rule prior to the effects of harmony.

(39) +ATR vs. +RTR specifications

Underlying	[i] [u]	[ɪ] [ʊ]	[e] [ɔ]	[a]
ATR	+			
RTR		+		

Derived	[i] [u]	[ɪ] [ʊ]	[e] [ɔ]	[e] [o]	[e] [ɔ]	[a]
ATR	+	-	-	+	-	-
RTR	-	-	+	-	-	-

The table above gives the vowels [ɪ, ʊ, e, o] as derived. Examples illustrating the environment that conditions their derivation can be observed in (40):

- (40) (a) /ɪ/
- | | | |
|-----|----------|------------------------------|
| [ɪ] | lum-a | 'plough' |
| [ɪ] | lum-is-a | 'plough+CAUSE' |
| | lum-iw-a | 'plough+PASS' |
| | lum-ile | 'plough+PAST' |
| | mɔ-lum-i | 'plougher' |
| | li-ru | 'lightning' |
| | li-buru | 'South African white farmer' |
-
- (b) /e/
- | | | |
|-----|----------|----------------|
| [e] | fel-a | 'finish' |
| [e] | fed-is-a | 'finish+CAUSE' |
| | fed-iw-a | 'finish+PASS' |
| | fed-ile | 'finish+PAST' |
| | pedi | 'two' |
| | tedu | 'bear' |
| | perekisi | 'peach' |

(c)	/ɔ/	[ɔ]	bɔn-a	'see'
		[o]	bontsha	'see+CAUSE' (/bon-is-a/)
			bon-iw-a	'see+PASS'
			bod-ile	'rot+PAST'
			kob-ile	'bend+PAST'
			kodu	'deep voice'
(d)	/ɔ/	[ɔ]	lɔm-a	'bite'
		[u]	lɔm-is-a	'bite+CAUSE'
			lɔm-iw-a	'bite+PASS'
			lɔm-ile	'bite+PAST'
			mɔdi	'root'
			mɔ-i-thut-i	'learner'
			mɔ-rut-i	'minister'
			mɔ-dumɔ	'noise'

In the data given above, note that low vowels occur with both [+ATR] and [-ATR] vowels and are not changed by [+ATR] vowels.

The standard pattern in a vowel harmony system, a pattern that is arguably basic even in Setswana, would have all vowels agreeing for [ATR]. The general harmonic pattern requires that words be either [+ATR] or [-ATR] as in cases such as in (41):

(41)	(a)	therɔ	‘sermon’
		kereke	‘church’
		ɔpel-a	‘sing’
		rek-a	‘buy’
		mɔ-lumɔ	‘medicine’
		bɔ-rɔkɔ	‘CP+sleep’
		tɔrɔ	‘dream’
	(b)	thoti	‘drop’
		mudi	‘root’
		pedi	‘two’
		kodu	‘deep voice’
		perekisi	‘peach’

3.1 Canonical Harmony

The basic harmonic assumption is that words should be of two types; words with [+ATR] vowels, such as the examples given in (41b), and words with no [+ATR] vowels, such as the examples in (41a). A significant number of actually attested forms exhibit precisely such canonical harmony as shown in the schematic surface representations of (42).

(42) Superficially harmonic data that is attested

V ₁	V ₂	i	u	ɪ	ʊ	ɪ	ʊ	e	o	ɛ	ɔ	a
i		iCi	iCu									
u		uCi	uCu									
ɪ		ɪCi	ɪCu									
ʊ		ʊCi	ʊCu									
ɪ						ɪCɪ	ɪCʊ			ɪCɛ	ɪCɔ	ɪCa
ʊ						ʊCɪ	ʊCʊ			ʊCɛ	ʊCɔ	ʊCa
e		eCi	eCu					eCe	eCo			
o		oCi	oCu					oCe	oCo			
ɛ										ɛCɛ	ɛCɔ	ɛCa
ɔ										ɔCɛ	ɔCɔ	ɔCa
a						aCɪ	aCʊ			aCɛ	aCɔ	aCa

There are various gaps in (42), and there are patterns not shown in (42) that appear on the surface, even though apparently disharmonic. Such cases are examined case by case.

Consider first the absence of forms involving either of the vowels [ɪ] or [ʊ] in final position. Some forms could be ruled out because they would be disharmonic (*[ɛCɪ], *[ɛCʊ], etc.), but some would be fully harmonic and yet do not occur:

(43) The absence of forms ending in [ɪ, ʊ]

	V ₂	ɪ	ʊ		ɪ	ʊ	ɪ	ɔ	e	o	ɛ	ɔ	a
V ₁													
i					*iCɪ	*iCʊ							
u					*uCɪ	*uCʊ							
ɪ					*ɪCɪ	*ɪCʊ							
ʊ					*ʊCɪ	*ʊCʊ							
ɪ													
ɔ													
e					*eCɪ	*eCʊ							
o					*oCɪ	*oCʊ							
ɛ													
ɔ													
a													

Such patterns are ruled out by the combination of two proposals. First, [ɪ, ʊ] do not occur underlyingly. As a result, they can only occur on the surface if they are derived by the rule of harmony. Second, the rule of harmony applies strictly from right to left. This means that the second vowel in the VCV sequence can never be [ɪ, ʊ]. The required rule of harmony is given in (44).

(44) Spread [+ATR] right-to-left



Note that by analysing [+ATR] as underlyingly linked to appropriate high vowels, three fully harmonic surface combinations of high vowels are predicted to occur: [i/u...i/u],

[i/ɔ...i/ɔ], [i/ɔ...i/u]. The fourth possibility, *[i/u...i/u], is ruled out because harmony does not apply from left to right. The three attested possibilities are illustrated in (45).

(45)	phiri	'hyena'	mmidi	'corn'
	kubu	'hippopotamus'	phuphu	'grave'
	kɔkɔ	'chicken'	phɔɔ	'bull'
	mɔtsɪ	'village'	bɔtshɪ	'sweet'
	lu	'egg'	mmui	'speaker'
	sɪg-ɔkɔl-a	'cut-REV-FV'	rom-ile	'send-PST'
	lɪd-ile	'cry-PST'	lɪb-ile	'watch-PST'

As a result of harmony, a large number of patterns occur where both vowels are advanced, for example, the patterns iCi, iCu, uCi, uCu, ɪCi, ɪCu, ʊCi, ʊCu. Examples of such forms are seen in the data in (46). With respect to the phenomenon under investigation, these forms are canonically harmonic because all vowels agree for the value [+ATR].

(46)	/ɪ-fifi/	ɪfifi	'darkness'
	/mɔ-ithuti/	mɔithuti	'student'
	/ɪ-ru/	ɪru	'cloud'
	/mɔ-di/	mɔdi	'root'
	/mɔ-ruti/	mɔruti	'shadow'
	/pɔdi/	pɔdi	'goat'

Patterns involving harmonic mixtures of advanced mid and high vowels, eCi, eCu, oCi, oCu, are illustrated in (47).

(47)	/thoti/	thoti	'drop'
	/pedi/	pedi	'two'
	/lori/	lori	'truck'
	/kodu/	kodu	'deep voice'
	/tedu/	tedu	'bear'
	/perekisi/	perekisi	'peach'

In addition to cases where all vowels are advanced, fully harmonic forms occur where all vowels are retracted. Some examples are given in (48).

(48)	kereke	'church'	goga	'pull'
	boboko	'brain'	uma	'needle'
	sifako	'hail'	maoto	'feet'
	libogo	'hand'	reka	'buy'
	lu	'egg'	moto	'person'
	kobo	'blanket'	thero	'sermon'

Such forms are expected given the analysis above.

3.2 Superficially disharmonic patterns

One class of potential forms where both vowels would surface as retracted is not attested, namely the class [e/o C u/ɔ]. In such forms, the mid vowels surface as advanced, not as retracted.

(49)	V ₂	ι	ω
	V ₁		
	e	eCι	ecω
	o	oCι	oCω
	ε	*εCι	*εCω
	ɔ	*ɔCι	*ɔCω

Some examples of attested forms are given in (50).

(50)	/sɛl-ʌ/	setsɪ	‘pick up+PAST’
	/sɪ-rem-ʌ/	sɪ-rem-ɪ	‘NEG+chop+FV’
	/sɪ-rɛk-ʌ/	sɪ-rɛk-ɪ	‘NEG-buy+FV’
	/ɛm-ʌ/	em-ɪ	‘stand+PAST’
	/bɔn-ʌ/	bon-ɪ	‘see+PAST’
	/fɔl-ʌ/	fots-ɪ	‘heal+PAST’
	/sɪ-gɔg-ʌ/	sɪ-gɔg-ɪ	‘NEG+pull+FV’
	/sɪ-lɔp-ʌ/	sɪ-lɔp-ɪ	‘NEG+ask+FV’
		Lwetsɪ	‘September’
		nwets-ɪ	‘drown+PAST’
	/sɪ-gɔts-ʌ/	sɪ-gɔts-ɪ	‘NEG+make fire+PAST’
	/sɪ-fɔs-ʌ/	sɪ-fɔs-ɪ	‘NEG+miss+PAST’
		lebɔg-a	‘thank’
		sebɔga-a	‘imagine’
		menɔl-a	‘overturn’
		senɔl-a	‘disclose’
		kgomɔ	‘cow’
		mɔ-lomɔ	‘mouth’
	/kɔb-ɔkɔl-a/	kob-ɔkɔl-a	‘bend+REV+FV’
	/rɛk-ɔkɔl-a/	rek-ɔkɔl-a	‘save+REV+FV’

These cases are interesting because they seem to require disharmony. Rather than surface with consistently retracted vowels, one observes that the mid vowel is advanced even though the following high vowel remains retracted. This result can be obtained by a rule of [+ATR] insertion.

(51) [+ATR] Insertion

$$\begin{array}{c}
 +\text{ATR} \\
 | \\
 \text{V} \rightarrow \text{V} / \text{ ___ C V} \\
 \qquad \qquad \qquad | \\
 \qquad \qquad \qquad +\text{High}
 \end{array}
 \qquad
 \begin{array}{l}
 \text{Conditions on target: Low/ATR} \\
 \text{ATR/RTR}
 \end{array}$$

This rule inserts [+ATR] onto a vowel under the following conditions. Firstly, the following vowel must be [+high]. Secondly, the target vowel must not be [+low], excluding [a] as a target (see below). Thirdly, the target vowel must not be [+RTR], excluding [ɪ, ɔ] as targets (see below). The effect of these conditions is to assign [+ATR] to mid vowels when followed by a high vowel.

Several points are noteworthy with respect to this rule. First, the examples in (50) show that the rule applies within roots and in derived contexts. This can be explained by the feature filling nature of the rule. Second, the rule's interaction with vowel height must be considered. Data such as that of (52) show that low vowels do not undergo the rule.

(52)	katsɪ	‘cat’
	narɪ	‘buffalo’
	nəw	‘foot’
	tharɔ	‘three’
	em-a	‘stand’
	rɛr-a	‘preach’
	rɔk-a	‘sow’
	ɔkam-a	‘oversee’
	ɔman-e	‘scold-PAST’
	gwejanɪ	‘last born child in a family’
	kgetlanɪ	‘collar bone’

Such data can be explained by the general impossibility of advancing low vowels. That is, the rule of [+ATR] Insertion is subject to Low/ATR: If [+low] then not [+ATR].

It is also the case that the rule does not apply if the potential target is high. This can be seen by a consideration of data as (53).

(53)	kɔkɔ	‘chicken’
	lu	‘egg’
	pɪle	‘heart’
	li-bɔli	‘fist’
	ɔsɪli	‘different person’
	nɔpɔts-ɪ	‘picked+PAST’
	sɪ-tsɔm-ɪ	‘NEG+hunt+FV’
	sɪ-rɔm-ɪ	‘NEG+sent+FV’
	sɪ-log-ɔlɔl-ɪ	‘NEG+knit+REV+FV’

It might appear that such cases require that the target of insertion be specified as mid. This would suggest a rule condition “If [+ATR] then [–high]”, a condition explicitly ruled out by the grounding condition hypothesis of Archangeli and Pulleyblank (1994). The problem can be resolved, however, by requiring that [+ATR] Insertion only target vowels that are not [+RTR]. That is, the rule is subject to the condition: ATR/RTR: If [+ATR] then not [+RTR]. In other words, even though the marked vowels [ɪ, ʊ] can be derived by ATR Spreading, they can not be derived [+ATR] Insertion. Recall that only [ɪ/ʊ] are underlyingly specified for [+RTR]. The pattern involving [±ATR] Insertion demonstrates that redundant values of [±RTR] can not be assigned until after [+ATR] Insertion.

One issue needs to be clarified. With [+ATR] Spreading, if a [+ATR, +RTR] combination is produced by the rule, then negation automatically converts this combination into [–ATR, –RTR]. Why does negation not produce a similar result here? An answer lies in the difference between conditions on specific rules and general conditions on representations. Negation takes place as a general repair when an illicit feature combination happens to arise. [+ATR] Spreading has no specific condition on not targeting [+RTR] vowels, but if a [+ATR, +RTR] combination happens to be produced, then negation repairs it. With [+ATR] Insertion, the rule itself prohibits a [+ATR, +RTR] combination. As such, the structural description of Insertion is not met when a vowel is specified as [+RTR], thereby preventing the rule from applying to the high vowels [ɪ, ʊ].

Because of the impossibility of assigning [+ATR] to low vowels (see section 2.2.2), and because of the strict directionality of harmony, various other disharmonic patterns are possible.

(54)	tiro	'work'	dikɛl-a	'sunset'
	mmino	'music'	dumɛl-a	'agree'
	puo	'language'	ditumɪ	'dialects'
	dimɔ	'an ogre'	pina	'song'
	tshimɔ	'garden'	padi	'novel'
	pula	'rain'	tau	'lion'
	mmadi	'reader'	maru	'clouds'
	tadi	'wild mouse'	tlhapi	'fish'
	magapu	'watermelon'		

Such patterns are directly accounted for by the analysis already presented.

The final patterns to be considered involve advanced mid vowels. Although relatively infrequent, it is possible to find a certain number of instances where an advanced mid vowel is found even though there is no high advanced vowel to its right.

(55)	telele	'long/tall'
	malekeleke	'an ascending road'
	tele	'type of grass'
	boro	'boar'
	betl-a	'mould'
	bes-a	'make fire'
	beny-a	'lightning'
	reets-a	'listen'
	fets-a	'complete'
	retl-a	'break up'
	fos-a	'miss'
	gots-a	'to light'
	kony-ana	'lamb-DIM'

The exceptionality of such forms can be accounted for by assuming that such morphemes contain a floating [+ATR] value in their lexical representation. In this way, such examples can be accounted for by assuming that the floating [+ATR] value links to the rightmost nonlow vowel, and then spreads from right to left by the rule of ATR Spreading. Note that spreading from an advanced mid vowel can only be to another mid vowel. See the examples in (56):

(56)	/m̩-r̩k-i/	m̩r̩ki	'buyer'
	/m̩-f̩eny-i/	m̩f̩enyi	'winner'
	/l̩-p̩odisi/	l̩p̩odisi	'police'
	/s̩-r̩ori/	s̩r̩ori	'truck'
	/s̩-b̩odu/	s̩b̩odu	'rotten thing'
	/s̩-b̩ok̩od̩i/	s̩b̩ok̩od̩i	'type of warm'
	/g̩-r̩ek-is-a/	g̩r̩ekisa	'to sell'
	/g̩-b̩on-is-a/	g̩b̩ontsha	'to show'

Since spreading to a mid vowel can be from either a mid vowel or a high vowel, while spreading to a high vowel can only be from another high vowel, a height condition needs to be added to ATR Spreading.

(57) Spread [+ATR] right-to-left (revised)



Condition: If V_i is +High then V_j is +High

The height condition must be satisfied before spreading can take place. That is, before a [+high] vowel can be targeted for spreading, it must be checked that a [+high] vowel is following.

There is some controversy as to whether the vowels [e/o] should be posited underlyingly or whether all such vowels should be derived, as proposed here (by spreading, insertion, or by exceptional linking). For discussion, see Clements (1991) and section 2.2.4 above. The decision that is reached for the restricted class of advanced mid vowels has certain consequences for the domain of grounding conditions. If all advanced mid vowels are derived, then the only advanced vowels underlyingly present in Setswana are high vowels. In this case, ATR/High (If [+ATR] then [+High]) is unviolated at the underlying level. On the other hand, if a restricted class of advanced mid vowels is underlyingly posited, then ATR/High can be considered an underlying tendency, but not an absolute requirement.

3.3 Summary

In this chapter, I have given a basic account of harmony in Setswana. Underlyingly, High vowels may bear [+ATR], as well, perhaps, as certain marked cases of mid vowels. Harmony causes any such [+ATR] value to spread from right to left. From high vowels, harmony affects any nonlow vowel; from mid vowels, harmony affects only preceding mid vowels. When the target of harmony is a high vowel, harmony is not neutralizing; this is attributed to lexical specifications of [+RTR] on the nonadvanced high vowels. Finally, mid vowels to the left of a high vowel are consistently advanced, attributed to a rule of [+ATR] Insertion.

The assumption made in this chapter is that the advanced mid vowels [e, o] do not occur except in two contexts. Firstly, they result from right to left spreading, as just mentioned.

Secondly, they occur as a result of a rule of insertion that assigns [+ATR] to any mid vowel when immediately followed by a high vowel [ɪ, ɔ]. In the latter case, mid vowels become [+ATR] even though the following vowel is [-ATR].

The analysis seems to be violated, however, by some forms. In a small number of cases, the vowels [e, o] occur in contexts where they are not derived by harmony. Given the rarity of such cases, they seem to require special treatment. One possibility would be to assume that all mid vowels, exceptional and unexceptional, are underlyingly present. Given some “exceptional” instances of [e, o], one could treat all instances of [e, o] as underlying. This approach has not been seriously entertained by anyone since it misses the generalisation that the vast majority of mid vowels occur in predictable environments. A second possibility would be to assume that most mid vowels are underlyingly [e, ɔ] and that rules of “insertion” (or “raising”) in combination with spreading result in advanced vowels [e, o]. The exceptional cases according to this analysis would be lexical instances of mid advanced vowels. Note that this analysis requires that the ATR/High condition be violated by exceptional cases underlyingly. A third possibility would be similar to the second, with advanced mid vowels being derived by insertion and spreading. The difference would be that exceptional cases would be derived by positing floating [+ATR] values that link by special rule. Under the floating analysis, ATR/High could hold without exception at the underlying level.

In general, grounded conditions play an important role in the proposed analysis. Underlying representations are governed by ATR/High (assuming that all mid advanced vowels are derived) but subsequent levels are not. Both underlying and derived levels are governed by ATR/Low, Low/ATR and ATR/RTR. Individual rules differ as to whether they are governed by these conditions. Spreading is governed by Low/ATR (or ATR/Low), preventing low vowels from being targeted by spreading. Insertion is

governed by Low/ATR (or ATR/Low) and ATR/RTR preventing both low and high retracted vowels from being targeted by insertion.

CHAPTER FOUR

4.0 [ATR] lexical morphemes

The general rule that governs the harmony process in Setswana, especially of suffixes has been explained as follows; both roots and prefixes can be affected by harmony, but subject to the following proviso. [+ATR] spreads only from one vowel to a second vowel of equal or lesser height. That is, from a high vowel [i] or [u], spreading affects both high and mid vowels [ɪ, ʊ] and [e, ɔ] but from a mid vowel [e] or [o], spreading only affects a mid vowel [e, ɔ]. The way in which this pattern is achieved was discussed in detail in chapter 3.

In addition to examining patterns of cooccurrence that occur in monomorphemic words, this thesis examines in some detail the case of derived words. In particular, a large class of words involving suffixes is examined in this chapter. The focus is on cases where high vowels occur in suffixes, high vowels that induce harmony on vowels to their left. In addition, certain special suffixes are examined.

Suffixes with a [+ATR] feature as part of their lexical entry have a high vowel [i]. As already mentioned above, the high vowels [i] is specified as [+ATR], and it has been shown that this feature is linked to [i] in the underlying representation. In other cases, high vowels may not be [+ATR] ([ɪ, ʊ]), and yet they can trigger [+ATR] insertion on an adjacent vowel. Finally, a restricted class of mid vowels in suffixes may be underlyingly [+ATR]. Examples of all these types are given in the following sections.

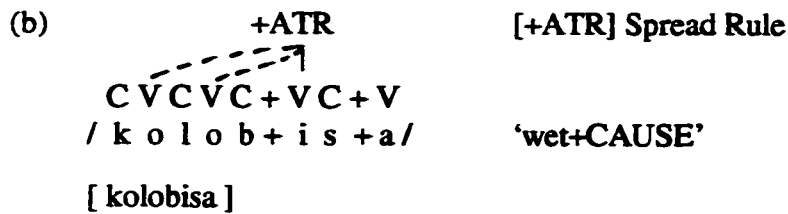
4.1 Causative suffix /-is-/

The examples below show how the specified [+ATR] high vowel [i] of this morpheme would change the unspecified root vowels causing them to surface as [+ATR]:

(58)	lɪm-a	'plough'	lɪm-is-a	'plough+CAUSE'
	bɪl-a	'boil'	bɪd-is-a	'boil+CAUSE'
	lɪk-a	'try'	lɪk-is-a	'try+CAUSE'
	sɪg-a	'cut'	sɪg-is-a	'cut+CAUSE'
	fɪt-a	'pass'	fɪt-is-a	'pass+CAUSE'
	rɛk-a	'buy'	rɛk-is-a	'buy+CAUSE'
	sɛl-a	'pick up'	sɛd-is-a	'pick up+CAUSE'
	fɛl-a	'finish'	fɛd-is-a	'finish+CAUSE'
	rɔk-a	'sow'	rɔk-is-a	'sow+CAUSE'
	lɔm-a	'bite'	lɔm-is-a	'bite+CAUSE'
	gɔg-a	'pull'	gɔg-is-a	'pull+CAUSE'
	fɔl-a	'cure'	fɔd-is-a	'cure+CAUSE'

The meaning entailed in this suffix is 'to cause to verb'. When this suffix is attached to a root with one of the vowels /ɪ, e, ɔ/, the root vowels will then become [+ATR] [i, e, u, o] respectively.

(59)	(a)	+ATR	Linked
		CVCVC+VC+V	
		/ k ɔ l ɔ b + i s + a /	'wet+CAUSE'



Iterative spreading has occurred in (59b) above.

4.2 Past tense suffix /-ile/

Like the causative suffix the past tense morpheme also has a [+ATR] high vowel and the feature will spread onto unspecified root vowels as observed in the following examples:

(60)	lum-a	‘plough’	lum-ile	‘plough+PAST’
	bul-a	‘boil’	bid-ile	‘boil+PAST’
	luk-a	‘try’	lik-ile	‘try+PAST’
	sug-a	‘cut’	sug-ile	‘cut+PAST’
	fit-a	‘pass’	fit-ile	‘pass+PAST’
	rek-a	‘buy’	rek-ile	‘buy+PAST’
	sel-a	‘pick up’	sed-ile	‘pick up+PAST’
	fel-a	‘finish’	fed-ile	‘finish+PAST’
	rok-a	‘sow’	ruk-ile	‘sow+PAST’
	lom-a	‘bite’	lum-ile	‘bite+PAST’
	gog-a	‘pull’	gog-ile	‘pull+PAST’
	fol-a	‘cure’	fod-ile	‘cure+PAST’

A cursory glance at this suffix might make one believe that the claim made earlier about the direction of spread is incorrect, since in the general harmonic patterns, the vowel [e] is

derived from /e/ through vowel harmony. In harmony patterns seen so far, the active feature is spread only from right to left as seen by comparing permissible sequences of [+ATR]...[-ATR] where spreading is inapplicable e.g. /dikela/ [dikela] 'sunset' (*[dikela]) with impermissible sequences of [-ATR] ... [+ATR] as in /rekisa/ [rekisa] 'sell' (*[rekisa]).

To account for the [+ATR] value of the final [e] in the suffix /-ile/, the following are possible analyses. Firstly, the analysis could potentially adopt one of the representations in (61) a,b,c.

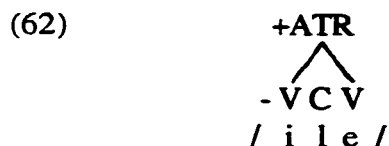
- (61) (a) +ATR
 |
 - V C V
 / i l e /
- (b) +ATR +ATR
 | |
 - V C V
 / i l e /
- (c) +ATR
 |
 - V C V
 / i l e /

The representation in (61a) fails because there is no rule that spreads [+ATR] from left to right. To postulate such a rule would derive incorrect results in the general cases.

Assuming that a floating [+ATR] feature is present as part of the lexical representation of this suffix, it could link from right to left to the mid vowel [e], as might appear to be the case, deriving the representation in (61b). Such a representation would violate the OCP, however, because the vowel [i] has a linked [+ATR] feature underlyingly.

Finally, note that the [+ATR] of [i] cannot be due to spreading, as would be necessary in (61c), for two reasons. First, spreading does not apply from a mid vowel to a high vowel (see chapter 2). Second, the result would be [ɪ], not [i].

How then can we satisfactorily account for the derivation of the surface /-ile/ suffix? The answer seems to depend on one's position with respect to advanced mid vowel exceptionality. If advanced mid vowels are absolutely ruled out underlyingly, then it is necessary to tolerate an OCP violation and posit a floating [+ATR] specification as in (61b). If advanced mid vowels are tolerated in exceptional instances, then the structure of the past tense suffix can involve an exceptional type of multiple linking involving +ATR lexically on a mid vowel as in (62):



4.3 Past tense suffix /-ɪ/

The morpheme /-ɪ/ occurs mostly in a negative past tense as in (63a) below and in some cases as a past tense suffix as in (63b) below. This morpheme only harmonically affects those verb stems with mid vowels [e, ɔ]:

(63)	(a)	sel-a	'pick up'	st-sel-ɪ	'NEG+pick+PAST'
		et-a	'visit'	st-et-ɪ	'NEG+visit+PAST'
		rek-a	'buy'	st-rek-ɪ	'NEG+buy+PAST'
		gɔg-a	'pull'	st-gog-ɪ	'NEG+pull+PAST'
		lor-a	'dream'	st-lor-ɪ	'NEG+dream+PAST'

(b)	sɛl-a	'pick up'	sets-ɪ	'pick+PAST'
	ɛm-a	'stand'	em-ɪ	'stand+PAST'
	bɔn-a	'see'	bon-ɪ	'see+PAST'
	ɔləl-a	'pick up'	olets-ɪ	'pick up+PAST'
	kɔpɛl-a	'button'	kopets-ɪ	'button+PAST'

The derivation of the advanced vowels in data given above may be accounted for by the Insertion rule given in (51) above. Note that [+ATR] Insertion does not apply to the forms in (64) because of the [+RTR] value underlyingly present on the vowels [ɪ, ɔ] (see chapter 2). The rule of [+ATR] Insertion is subject to the condition that its targets not be [+RTR], that is, "If [+ATR] then not [+RTR]".

(64)	bul-a	'boil'	buts-ɪ	'boil+PAST'
	nɪs-a	'rain'	-nɪs-ɪ	'rain+PAST'
	lum-a	'plough'	-lum-ɪ	'plough+PAST'
	sɪg-a	'cut'	-sɪg-ɪ	'cut+PAST'
	mɪn-a	'fold'	-mɪn-ɪ	'fold+PAST'
	kɔm-a	'bite'	-kɔm-ɔ	'bite+PAST'
	bɔts-a	'ask'	-bɔts-ɪ	'ask+PAST'
	rɔm-a	'send'	-rɔm-ɪ	'send+PAST'
	kɔp-a	'request'	-kɔp-ɪ	'request+PAST'

4.4 Locative suffix /-ing/ (historically -ni)

Like the past tense morpheme /-ile/ and the causative morpheme /-is/, this suffix has an underlying [+ATR] lexical feature which may be spread onto target vowels in the noun stem as in the examples below.

(65)	kereke	/kɛrɛkɛ-ing/	kerekeng	'church+LOC'
	si-lepe	/si-lepe-ing/	sulepeng	'axe+LOC'
	li-bogō	/li-bogō-ing/	libogong	'hand+LOC'
	pale	/pale-ing/	paleng	'pole+LOC'
	kōbo	/kōbo-ing/	kōbong	'blanket+LOC'
	li-rakō	/li-rakō-ing/	lirakong	'wall+LOC'
	li-fatshu	/li-fatshu-ing/	lifatshmg	'world+LOC'
	kgomō	/kgomō-ing/	kgomung	'cow+LOC'

After the spreading of the active [+ATR] feature, the vowel [i] is deleted by a Vowel Deletion Rule, the reason for the deletion being that, Setswana requires only one vowel at nucleus position in a syllable after suffixation and re-syllabification.

The data given above supports the restrictions of the spread rule given above, that a [+ATR] mid vowel may not target a high vowel [ɪ, ɔ] for spreading.

When the final vowel of the noun stem is the low vowel [a], vowel coalescence will occur instead of [ATR] harmony.

(66)	/thaba-ing/	thabeng	'mountain+LOC'
	/naga-ing/	nageng	'veld+LOC'
	/patla-ing/	patleng	'pocket+LOC'
	/ma-gala-ing/	magaleng	'coal+LOC'
	/li-tagwa-ing/	li-tagweng	'drunker+LOC'
	/si-baga-ing/	si-bageng	'necklace+LOC'
	/karata-ing/	karateng	'card+LOC'



4.5 Deverbative suffix /-i/

Like the causative /-is-/ and past tense /-ile/ suffixes discussed above, the deverbative suffix has a high vowel /-i/ that is specified as [+ATR]. The [+ATR] feature will spread to both high vowels [ɪ, ɔ] and mid vowels [ɛ, ɔ] as accounted for by rule (57). Data in (69) show the derivation of the nouns from verbs which includes a noun class prefix and the suffix /-i/.

(69)	lɪ-a	‘cry’	/mɔ-lɪ-i/	mɔ-lɪd-i
	lɪm-a	‘plough’		mɔ-lɪm-i
	lɪb-a	‘look’		mɔ-lɪb-i
	rɛk-a	‘buy’		mɔ-rɛk-i
	sɛb-a	‘gossip’		mɔ-sɛb-i
	bɛlɛg-a	‘carry on back’	/mɔ-bɛlɛg-i/	mɛlɛg-i
	lɔg-a	‘knit’		mɔ-lɔg-i
	rɔk-a	‘sow’		mɔ-rɔk-i
	kɔlɔp-a	‘throw’		mɔ-kɔlɔp-i
	bɔn-a	‘see’	/mɔ-bɔn-i/	mɔn-i
	kɔb-a	‘bend’		mɔ-kɔb-i

Note that spreading of the [+ATR] value from the suffix does not go beyond the root to the prefix as in (70) below. Spreading from root to prefix can only occur if the root vowel on the root vowel is /i, u/ as in (71) below.

Consider first the case of a mid vowel root. To derive a noun in class 1 from the verb /rek-a/ 'buy', the prefix /mɔ/ and suffix /-i/ will be attached to the verbal root /rek-/.

- (70) (a)
$$\begin{array}{c} +\text{ATR} \\ | \\ \text{CV} + \text{CVC} + \text{V} \\ /m \ \omega \ r \ e \ k + i/ \end{array}$$
 'buyer'
- (b)
$$\begin{array}{c} +\text{ATR} \\ \text{CV} + \text{CVC} + \text{V} \\ m \ \omega \ r \ e \ k + i \\ \text{[m}\omega\text{reki]} \end{array}$$
 [+ATR] Spread Rule 'buyer'

Spreading has occurred from the suffix vowel to the root vowel, leaving the prefix vowel to surface as [-ATR]. Spreading cannot affect the prefix because [+ATR] cannot spread from a mid vowel to a high vowel (see chapter 2).

Consider now a high vowel root.

- (71) (a)
$$\begin{array}{c} +\text{ATR} \\ | \\ \text{CV} + \text{CVCV} \\ /m \ \omega \ d \ u \ m \ \text{ɔ}/ \end{array}$$
 'noise'
- (b)
$$\begin{array}{c} +\text{ATR} \\ \text{CV} + \text{CVCV} \\ m \ \text{ɔ} \ d \ u \ m \ \text{ɔ} \\ \text{[m}\omega\text{dum}\text{ɔ}]} \end{array}$$
 [+ATR] Spread Rule 'noise'

The difference as can be observed in (71) is the presence of a [+ATR] vowel [u]. I argue that [ATR] harmony has occurred because both the trigger and target of spreading are high. Therefore, the prefix vowel [ɔ] has become [+ATR], that is [u].

When the noun prefix vowel is a [+ATR] vowel [i], the feature will not be spread onto root vowels, accounted for by the right-to-left directionality built into the rule (57) above. The active [+ATR] feature will only spread from right to left and not from left to right.

(72) +ATR
 |
 C V + C V C V
 / d i + k ɔ b ɔ / 'blankets'
 [dikɔbɔ]

Note that if the source of harmony is a suffix, and if root and prefixes are both high, one would have expected harmony to apply from the suffix all the way to the prefix in an example like [mɔ-lib-i]. In fact, harmony spreads [+ATR] from the suffix to the root, but the prefix in such a case is unaffected. A possible account of such cases would be to impose the following requirement on harmony: [+ATR] can spread to a high vowel in a prefix only if the source of the [+ATR] value is not [+RTR]. That is spreading onto a prefixal high vowel takes place only from an underlying [+ATR] vowel, not from an advanced vowel whose [+ATR] value is derived by harmony. We leave for future work the issue of how to formulate such a condition.

4.6 Demonstrative suffixes

In Setswana, the demonstratives are derived from the noun class prefixes and thus identify the different positions of nouns. The first position signifies 'this' or 'those' and refers to something relatively near to the speaker. Cole (1937:130) states that:

'the semi-open vowels [e] and [o], when occurring in demonstrative pronouns, are always of raised quality.'

As will be shown below, the suffixes for demonstratives for all three positions are underlyingly specified for [+ATR]. Moreover, since the vowel of the class prefix deletes when in contact with the demonstrative morpheme, there is no real opportunity to observe harmony. The demonstrative forms are nevertheless included here as they constitute a common configuration where [+ATR] mid vowels surface with no high vowel to the right.

4.6.1 First position demonstrative

I assume that the demonstrative morphemes have a lexical [+ATR] value, either prelinked or floating depending on the treatment of unconditioned mid advanced vowels. (Class prefix=CP; First Position Demonstrative= 1st Pos. Demon.)

(73) (a) +ATR
 (1)
 C V - V
 (CP)

(b)	Noun	CP + 1st Pos.Demon.		
	sɪ-tɪhɑɾɪ	/sɪ + e/	se	'this tree'
	ɪt-bɔɔxɔ	/ɪt + e/	le	'this hand'
	mɪ-kɔɔɔ	/mɪ + e/	e	'these boats'
	mɔ-tɪ	/mɔ + o/	o	'this village'
	mɔ-tɪhɑlɑ	/mɔ + o/	o	'this example'
	mɔ-riri	/mɔ + o/	o	'this hair'
	bɔ-bɔkɔ	/bɔ + o/	bo	'this brain'
	mɑ-lɑpɑ	/mɑ + a/	a	'these homes'
	mɑ-sixɔ	/mɑ + a/	a	'these/those nights'

di-buka	/di + e/	tse ⁷	'these/those books'
di-jo	/di + e/	tse	'these food'
di-limo	/di + e/	tse	'these/those years'

The following observations can be made about (73):

- (i) If the prefix vowel is [+Back] then the suffix vowel is [+Back] and if the prefix vowel is [-Back] then the suffix vowel will be [-Back]. When the prefix vowel is low and [-ATR], the vowel of the suffix also surfaces as low and [-ATR].
- (ii) The prefix vowel is deleted in cases where the prefix does not have a nasal consonant; when the prefix has a nasal consonant, both the consonant and the prefix vowel are deleted after suffixation. This is a general trend for the formation of most pronouns in Setswana.

With regard to its harmonic value, the only point to note is that the demonstrative is mid and [+ATR].

4.6.2 Second position demonstrative

The second position demonstrative morpheme like the first position, shows that a [+ATR] feature is lexically specified with this morpheme. The general trend has been to say that the second position demonstrative morpheme is the [+ATR] vowel /-o/ and is attached to the first position demonstrative. The problem with that analysis would be twofold: an [+ATR] mid vowel must be posited, and there is a violation of the OCP.

⁷ Affrication has occurred.

(74)	1st Pos. Demon +ATR		V	-	2nd Pos. Demon suffix +ATR		V
	e.g. lɪ -		e				o

I assume that the analysis of this morpheme can be given along the lines of (75) to account for the data in (76):

(75)	+ATR	└──┘	└──┘
	e.g. lɪ -	e	o

The underlying [+ATR] feature is either prelinked to the final suffixal vowel, or links to it from right to left; it then spreads to the preceding mid vowel e.g. 'leo'; if the preceding vowel is [+Low] then spreading will be blocked e.g. 'bao'. The suffix is attached to the noun class prefix along the lines of (73); the prefix vowel will delete:

(76)	Noun	NP + 2nd Pos. Demon.		
	ba-thɔ	/ba + ao/	bao	'those people'
	ma-xapu	/ma + ao/	ao	'those watermelons'
	lɪ-rakɔ	/lɪ + eo/	leo	'that wall'
	sɪ-tlhari	/sɪ + eo/	seo	'that tree'
	lɔ-bɔnɛ	/lɔ + oo/	loo	'that lamp'
	mɔ-tsɪ	/mɔ + oo/	oo	'that village'
	n(ɪ)-ku	/nɪ + eo/	eo	'that sheep'
	n(ɪ)-namanɪ	/nɪ + eo/	eo	'that calf'
	di-kɔbɔ	/di + eo/	tseo	'those blankets'
	di-nɔga	/di + eo/	tseo	'those snakes'

The same observations as those discussed in 4.6.1 are made except that the suffix consists of two suffixal vowels. The initial suffix vowel seems to be derived like the suffix vowel of the 1st position demonstrative.

4.6.3 Third position demonstrative

It is argued that the analysis for the derivation of the third position demonstrative will be as in (77) below, where the feature is linked to the morpheme /-Vle/.

(77)	Noun	NP+ 3rd Pos.Demon.		
	sɪ-tlharɪ	/sɪ+ele/	sele	'that tree'
	li-rakɔ	/li+ele/	lele	'that wall'
	ma-bɔxɔ	/ma+ale/	ale	'those hands'
	ma-riga	/ma+ale/	ale	'those winters'
	di-buka	/di+ele/	tsele	'those books'
	di-lumɔ	/di+ele/	tsele	'those years'
	n(ɪ)-naga	/nɪ+ele/	ele	'that veld'
	mɔ-tsɪ	/mɔ+ole/	ole	'that village'
	mɔ-lumɔ	/mɔ+ole/	ole	'that medicine'

The formation of the third position demonstrative is similar to the second position demonstrative, again illustrating an mid vowel affix with lexical advancement, either prelinked or floating.

4.7 Reversive suffix /-ᵛᵛᵛ-/

The reversive suffix like the past tense suffix /-ᵛ/ initiates the insertion of the [+ATR] feature, i.e. this supports the insertion rule given in (51) above. When this suffix is attached to roots with a mid vowel /ε, ɔ/ the mid vowel becomes [+ATR], [e, o] respectively. The examples below show the effect of the reversive suffix especially to stems with mid vowels [e, ɔ]. The meaning entailed is to reverse an action.

(78)	rek-a	‘buy’	rek-ᵛᵛᵛ-a	‘buy+REV’
	sel-a	‘pick up’	sel-ᵛᵛᵛ-a	‘buy+REV’
	ep-a	‘dig’	ep-ᵛᵛᵛ-a	‘dig+REV’
	bes-a	‘make fire’	bes-ᵛᵛᵛ-a	‘make fire+REV’
	ɔb-a	‘bow’	ob-ᵛᵛᵛ-a	‘bow+REV’
	bɔf-a	‘tie’	bof-ᵛᵛᵛ-a	‘tie+REV’
	kɔb-a	‘bend’	kob-ᵛᵛᵛ-a	‘bend+REV’
	*men-a		men-ᵛᵛᵛ-a	‘overthrow’ (Government)

However when the suffix is attached to a root with high vowels [i, ɔ] these vowels will not undergo any harmony. That is, even though the feature could be inserted by rule (51), it will not link to these high root vowels as shown in (79):

(79) [+ATR] Insertion inapplicable

	CVC+VCVC-V			
	/ s t g + ɔ l ɔ l - a / ‘cut+REV’			
	bɔts-a	‘ask’	bɔts-ᵛᵛᵛ-a	‘ask repeatedly’
	lum-a	‘plough’	lum-ᵛᵛᵛ-a	‘reap’
	rɔk-a	‘sow’	rɔk-ᵛᵛᵛ-a	‘unsown’
	mɔn-a	‘fold’	mɔn-ᵛᵛᵛ-a	‘unfold’

CHAPTER FIVE

5.0 CONCLUSION

It is proposed in this study that vowel harmony in Setswana is governed by the following two parameters:

- (i) Being a [+high] vowel in Setswana plays two major roles in the harmony process. Firstly, high vowels are the only vowels that bear [+ATR] underlyingly (with the possible exception of the very few cases of mid vowels discussed). Secondly, the high vowels will condition the insertion of the [+ATR] to their left.
- (ii) The active [+ATR] which is linked underlyingly to high vowels [i, u], will spread iteratively from right-to-left. Spreading takes place from a high vowel [i, u] to any nonlow vowel [ɪ, e, ɔ, ɔ]; from a mid vowel [e, o], [+ATR] spreads only to nonhigh vowels.

I have, in this study argued for an account adopting two features [\pm ATR] and [\pm RTR] as distinct from each other, for the specification of the six high vowels [i, ɪ, ɪ, ɔ, ʊ, u] in Setswana. The feature [\pm RTR] seems to be relevant especially to distinguish the underlying [+ATR] vowels [i, u] from the derived vowels [ɪ, ʊ].

It has been shown that vowel harmony in Setswana does not need to resort to an unbounded feature 'open' as argued for by Clements (1991) for Sesotho, or the 'height assimilation' process argued for by Khabanyane (1991) for Sesotho. Instead, Setswana has been analysed in terms of a process of [ATR] harmony, where an active [+ATR] autosegmental feature spreads onto [ATR]-bearing units unspecified for the feature.

Another assumption made is that the theory of Grounding Conditions argued for by Archangeli and Pulleyblank (1994) can, to a great extent, account for [ATR] vowel harmony in Setswana. That is, the interaction between features plays an important role in the analysis of the phonological processes of vowel harmony. The conditions set by the language require that, for harmony to occur, ATR must be in a path with [+high]. The Grounding Conditions that play a role in Setswana harmony are the following:

- (i) ATR/High: If [+ATR] then [+High] and not [−High]
- (ii) ATR/Low: If [+ATR] then [−Low] and not [+Low]
- (iii) Low/ATR: If [+Low] then [−ATR] and not [+ATR]
- (iv) ATR/RTR: If [+ATR] then [−RTR] and not [+RTR]

The first condition, ATR/High, constitutes a tendency, not an absolute requirement. Most underlying representations respect this condition and the rule of [+ATR] insertion is governed by the condition. The second and third conditions are absolute: low advanced vowels are never tolerated in Setswana. The fourth condition, ATR/RTR, is unviolated on the surface. When a combination [+ATR, +RTR] arises via the spreading of [+ATR], it is immediately repaired by negation to create [−ATR, −RTR].

There are however some problems that still need to be looked into, for example, as concerns certain cooccurrence restrictions involving vowels and consonants. In particular, many of the cases where mid vowels appear as advanced involve contexts with particular types of consonants. Whether there is some consonantal effect involved in the ATR patterns of such vowels is left for future research.

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