Positionally restricted tone systems in Papuan languages

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Abbreviations

Glosses		(Alternative names)
1, 3	first person, third person	
ADD	additive	
ADVERS	adversative	
DEF	definite	
ERG	ergative	
FUT	future	
FUT.NEG	negative future	
FUT_1.DEF	definite future	speaker absent (Doble 1987)
IND	indicative	
PL	plural	
POSS	possessor	
PST_1.DEF	definite past 1	past today (Doble 1987)
PST_1.INDEF	indefinite past 1	conditional (Doble 1987)
PST_2.INDEF	indefinite past 2	
REL	relative clause	
Q	interrogative	
SG	singular	
Theoretical		
CC	Colored Containment	
GEN	Generator	
OT	Optimality Theory	
ROTB	Richness of the Base	
Phonological		
#, %	word edge, phrase edge	
$\rightarrow$	direct association	
$\looparrowright$	indirect association	
►	colorless association	
Ft	foot	
H, L, M	high, low, mid tone	
μ	mora	
σ	syllable	
τ	tone	
V	vowel	
ω	phonological word	

1 Introduction

Positionally restricted tone systems, i.e. systems where contrastive tone is restricted to a certain position in a word, have often been analyzed using a restricted set of input melodies[1]. In this thesis I will show, that it is possible and even preferable to analyze positionally restricted tone systems using Optimality Theory (Prince & Smolensky 1993) with strict enforcement of the richness of the base principle, i.e. no restrictions on the input.

There are three main arguments in favor of this analysis, that I will show on three different Trans-New-Guinea languages with positionally restricted tone systems. Evidence comes from the morphophonology. First, stems can change their tonal melody under specific morphological conditions. This can be seen in Mee, where some nouns change their melody in a specific context, while others do not (cf. (1)). It can be analyzed with Richness of the base as a difference in the underlying representation of the affix, that shift their contrastive tone to the stem. The resulting tonal melody is a also found on other simple stems (cf. (1c.)).

(1) Morphophonological tone change in Mee

a. kágò + mà → kágómà ‘and a branch’
b. gótì + mà → gógìmà ‘and a bread’
c. ágíyà ‘netbag’

The second argument comes from Kairi. The surface melody of complex forms is not only dependent on the surface melody of the stem in isolation and the usual surface melody of the affix. In (2) there are two instances of concatenation of two morphemes with a LH surface melody. Since the resulting melody also depends on the stem, an analysis with different underlying patterns following Richness of the Base is possible, where the contrast is neutralized in isolation.

(2) Unpredictable differences in Kairi tone sandhi

a. ǐ + wɔ̀tú → íwɔ́tû ‘fire brand’
b. hǎ + kɛ̀á → hàkèá ‘throw upriver’

Third, in Siane, the tonal melody is dependent on other phonological properties of a word, such as syllable count. High-Low patterns never occur on monosyllabic nouns, even though they can occur on bisyllabic ones and there is no general constraint against contour tones. Certain tonal patterns are restricted to words with certain

[1] I want to thank Jeroen Breteler and the Phonology Reading Group at the University of Leipzig for fruitful discussions.

syllable counts, which makes constraints on the surface not only a possible way of analyzing this pattern; it is even necessary to assume them.

(3) Phonological factors in Siane tone assignment (non-final forms)

a. nó 'to eat', kò 'rain', yǒ 'fire', *nô

b. kélá 'frog', mèìnà 'payment', lónò 'work', kêfá 'meat'

Thus the overall argument is that one can analyze these patterns without restrictions on the input, whereas constraints on the output are needed to account for different alternations. This makes an analysis within Optimality Theory with strict enforcement of Richness of the base an attractive alternative. The most important surface true constraints in the analysis will either restrict tones to certain prominent positions in a word or they will restrict the kind of tones that can occur in a certain word-level position.

Crucially these constraints will make reference to two important concepts. One are the prominent positions on an edge, such as the first mora or the last foot. The second concept is related. If the constraints relate tones to prominent positions on different hierarchical levels, but tones are cannot be associated to more than one Tone Bearing Unit, indirect association is needed. A constraint can thus demand a tone to be associated to a mora, that in turn is associated to the first foot in a word.

The goal of this thesis is twofold. On the one hand I will show that an analysis of these positionally restricted tone systems is possible and even desirable as explained above. On the other hand I will show data of Papuan languages, whose tone systems have been analyzed as pitch accents, word tone or proper tone language. These languages are nevertheless connected, because they restrict their tonal contrast to a certain position in a word. I will provide a structured qualitative comparison of these three languages and also make data available again, that otherwise might get lost in older papers, where they were deeply embedded in a theoretical discussion and thus unavailable to the naive reader.

This thesis will start with a presentation of the relevant data for each of the languages. These descriptions will be summarized and the data compared. After explaining the theoretical framework the analysis will be couched in, I will proceed with the analysis of each language's tone system. I will conclude with a concise summary of the comparison and the analysis, the resulting predictions and a short outlook.

2 Data

The following three sections will consist of the descriptions of data from Mee, Kairi and Siane. They will follow the description of one source each, since there is no more data available on the tonal systems of these languages. I will use IPA notation for tone, where [á] signifies a high tone, [à] a low tone, [ǎ] a rising tone, [â] a falling tone and [a᷈] a peaking tone. Each desription will start with the phonological descriptions of tone, before moving on to possible morphophonological alternations.

I will also attempt to compare the languages through predesigned surface true categories. The phonological classification will draw some inspiration from Hyman (2009) as he argues that certain restrictions that apply to stress languages might also apply to tone languages. The only theory-independent categories are *obligatory H* and *cumulative H*. The former describes the property of having at least one high tone in each word, whereas the latter distinguishes languages based on the question, if they allow for more than one high tone in a word. The third parameter is taken from Donuhe (2005) and describes if the languages allows contrast on monomoraic (monosyllabic) words. In addition I will describe the position to which the tonal contrast is restricted. The phonological parameters are summarized in (4).

(4) Typological Parameters for restricted tone systems

a. Obligatory H: Does every word in the language bear at least one high tone?

b. Cumulative H: Does every word in the language have at most one high tone bearing mora/syllable?

c. Monosyllabic (monomoraic) contrast: Is there more than one pattern available for monomoraic/monosyllabic words.

d. Position of contrast: Which position is the contrastive tone restricted to?

The parameters I will use for the morphophonological processes are based on terms that are usually used for describing vowel harmony. Affixes that bear a *dominant* feature value are able to influence the feature value of the stem, while those that bear a *recessive* feature value do not influence the stem at all and in turn adjust to the stem's feature value. These terms have been expanded to affixes influencing the tonal and/or stress patterns of stems (cf. e.g. Inkelas 1998). I will further expand this typology. The main questions are if the tone of an affix influences the tone pattern of the stem and if an affix is influenced by the stem. In terms of triggers and undergoers one could also reformulate these questions as: does the affix undergo changes triggered by the stem and does the affix itself trigger a change in the stem. If we cross-classify affixes by these questions, we get the affix typology in (5).

(5) Affix typology

	trigger	non-trigger
undergoer	active	recessive
non-undergoer	dominant	neutral

The new affix types are *neutral* affixes, which neither influence the stem nor are influenced by the stem and the *active* affixes, which do both; they undergo a change because of the stem and they trigger a change in the stem. The term *neutral* is again borrowed from vowel harmony descriptions, which includes opaque and transparent affixes. It is important though, to distinguish morphophonological processes that are triggered by affixes and general phonological processes that are dependent on the syllable count etc. For each language I will describe if there are affixes of these types.

2.1 Mee

The following descriptions are based on data and generalizations in Hyman & Kobepa (2013), which focus on the Paniai dialect. Mee (ISO 639-3: ekg, Glottocode: meee1238), which is also known as Ekari, Ekagi or Kapauku, has two contrasting tone patterns for words of every possible syllable structure (cf. (6)). Under certain morphological and phonological conditions one pattern changes into the other.

In the first pattern the first mora bears a high tone, whereas all other moras in the word are low toned. The only difference in the second pattern is, that the first two moras bear a high tone instead of only the first one. Following Hyman & Kobepa (2013) I will call the first pattern A and the second pattern B. The same regularities also hold for longer words (cf. (6b)).

(6) Examples of tone patterns in Mee

		$\mu\mu$	$\mu.\mu$	$\mu\mu.\mu$	$\mu\mu.\mu\mu$	$\mu.\mu.\mu$	$\mu\mu.\mu.\mu$
a.	A	bóù	údò	gáàbò	múùmàì	áyàmù	máàkàdò
		'wind'	'heavy'	'quiet'	'to finish'	'chicken'	'true'
	B	bóú	údó	gáátì	búúmàì	ágíyà	áákàtà
		'to skin'	'testicle'	'ten'	'to swim'	'netbag'	'to belch'

		μ.μ.μμ	μμ.μ.μμ	μ.μ.μ.μ	μ.μ.μμ.μ
	A	pútèwèè	máàgìyòò	nákàpìdù	ítònààgò
b.		‘knife’	‘what’	‘squash’	‘today’
	B	dókégàà	tíítìwàà	tókápùgà	kápógèìyè
		‘waves’	‘student’	‘gecko’	‘paper’

There are only two exceptions to this generalization. Monomoraic words do not show contrast and words that start with a sequence of a light syllable followed by a heavy syllable bear a high tone on the whole second syllable if it is a pattern B stem. I will call this surface pattern B_2 (cf. (7)).

(7) Examples of monomoraic and exceptional B_2 tone patterns in Mee

	μ	μ.μμ	μ.μμ.μ	μ.μμ.μμ	μ.μμ.μ.μ
A		énàà	áwèìdà	kónàìyòò	kédèètìyà
	bó	‘good’	‘daytime’	‘beard’	‘stomach’
B	‘leg’	énáá	étáídà	áyáíyòò	yégéénàkà
		‘ripe’	‘light’	‘to tickle’	‘glorious’

If we look at morphophonological alternations, they all involve a change from pattern A to pattern B. This change, however, is restricted to certain morphological categories. In (8) we can see morphological contexts, that do not cause any change in the lexical tone pattern, and are thus neutral. These include the citation form of nouns and verbs together with some verbal aspect marking. I will call these context 1.

(8) Non-alternating verbal forms in context 1

	citation form		PST$_1$.DEF
a.	wá-ì ‘to strip bark’	→	wá-àgà
b.	wé-í ‘to evaporate’.	→	wé-égò
c.	úwì-ì ‘to go’	→	úwè-ègà
d.	áwí-í ‘to put into’	→	áwé-égà
e.	wítókà-ì ‘to choose’		wítókè-ègà

They contrast with another set of morphological contexts, where all words are changed to pattern B and the contrast between the patterns is neutralized (cf. (9)). These will be called context 3. Mostly verbal affixes are dominant in this context.

(9) Alternations in context 3

	Citation		PST$_2$.INDEF	FUT$_1$.DEF
a.	dó-ù 'to see'	→	dóó-tà	dóó-tòògà
b.	yó-ú 'to see'	→	yóó-tà	yóó-tòògà
c.	úwì-ì 'to go'	→	úwí-tà	úwí-tòògà
d.	áwí-í 'to put into'	→	áwí-tà	áwí-tòògà
e.	wítókà-ì 'to choose'	→	wítók-ìtà	wítók-ìtòògà

The most intriguing contexts are those where we see a split in stems consisting only of two light syllables (henceforth pyrrhic stems), which I will term context 2. Some pyrrhic stems change from pattern A to pattern B in this context, other pattern A stems show no change at all. These contexts include several nominal enclitics and some verbal tenses. I will call the stem class that undergoes such changes A_{ii} and the stem class that does not undergo such changes A_i. As you can see in (10), the context is not dependent on the phonological shape of the affixes. Hyman & Kobepa (2013) do not give examples for noun stems with a different syllable weight structure. Instead they state that these nouns do not change. In contrast verb stems with other syllable weight structure receive pattern B. An example of a stem A_{ii} with the dominant plural clitic is given in figure 1.[2] It is clearly visible that the stem *píyà* changed from pattern A to pattern B_2

(10) Alternating nominal and verbal forms of phyrric stems in context 2

[2]The speaker is a young male speaker of the Tigi dialect, which does not seem to make a difference here. I elicited the data myself and it matches the impressionistic descriptions in Hyman & Kobepa (2013)

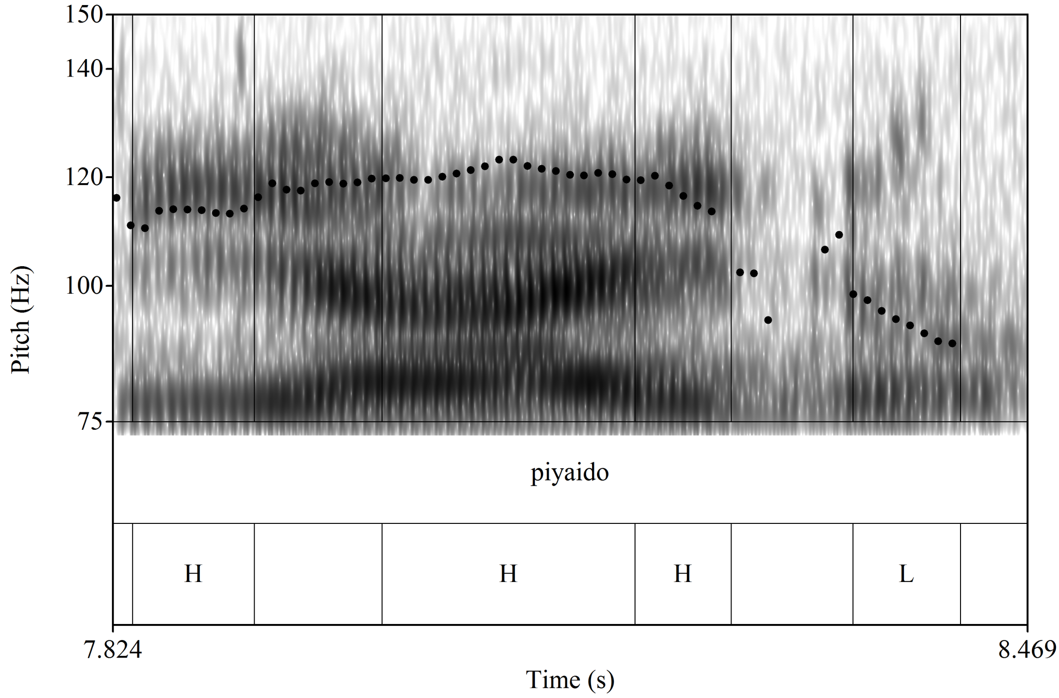


Figure 1: Pitch track for *píyáídò* 'trees' from *píyà* 'wood' and *-ido* PL

	citation		form with enclitic
a.	kágò 'branch'	→	kágó=mà 'and a branch'
b.	yókà 'child'	→	yóká=kàà 'with a child'
c.	mógò 'stone'	→	mógó=ùdò 'stones'
d.	módò 'belly'	→	módó=yàgò 'having a belly'
e.	púgà 'tail'	→	púgá=màìdà 'on the tail'

	citation		PST$_1$.INDEF
f.	yákì-ì 'to grasp'	→	yákí-pà
g.	múgà-ì 'to catch'	→	múgá-pà

(11) Non-alternating nominal and verbal forms in context 2

	citation		form with enclitic
a.	gótì 'bread'	→	gótì=mà 'and bread'
b.	bádò 'foot'	→	bádò=kàà 'with the foot'

	citation		PST$_1$.INDEF
d.	kébà-ì 'to open'	→	kébà-pà
g.	úwì-ì 'to go'	→	úwì-pà

Unfortunately there is not enough data for compounds and no data at all on verbal agreement affixes to base solid generalizations upon them. To summarize the empirical generalization about morphophonology, we have seen that at least phyrric stems can be grouped into three different classes, based on their behavior: A(i), A(ii) and B and that affixes can be grouped into three morphophonological contexts 1, 2 and 3. Other stems behave similarly in context 1 and 3, but different in context 2.

(12) Stem classes and morphological contexts in Mee

Contexts:	1	2 (phyrric stems)	3
A(i)	A	A	B
A(ii)	A	B	B
B	B	B	B

In Mee we have thus seen a pattern where tonal contrast is restricted to the second mora. The first mora is always high toned, whereas the moras following the contrastive mora are always low toned. There is also a intriguing process where pattern A changes into pattern B under certain morphological, phonological and lexical conditions.

2.2 Kairi

Kairi (ISO 639-3: klq, Glottocode: rumu1243) is also known as Rumu (Trans-New-Guinea, Papua-New-Guinea) (cf. Cahill (2011:9)) . Its tone system is analyzed in Newman & Petterson (1990), whose data I will use in the following description. Kairi tone phonology features four distinct patterns, which are enforced independent of phonological, prosodic, morphological and even lexical information. In Kairi the only case where we can see all possible surface tones is on monosyllabic words as shown in (13). Monosyllabic words can bear up to three tones. All combinations of high and low tones are allowed with only two exceptions. There is no dipping tone (HLH) and no word with only low tones.

(13) Monosyllabic words in Kairi

a. ké
‘pitpit’

b. pá
‘pulverized’

c. hó
‘tree species’

d. kě
‘shellfish species’

e. pǎ
‘split’

f. hǒ
‘bag’

g. kê
‘crescent shell’

h. pê
‘by, with’

i. hê
‘blow’

j. kě̂
‘tree species’

k. pǎ̂
‘tree species’

l. hǒ̂
‘grub’

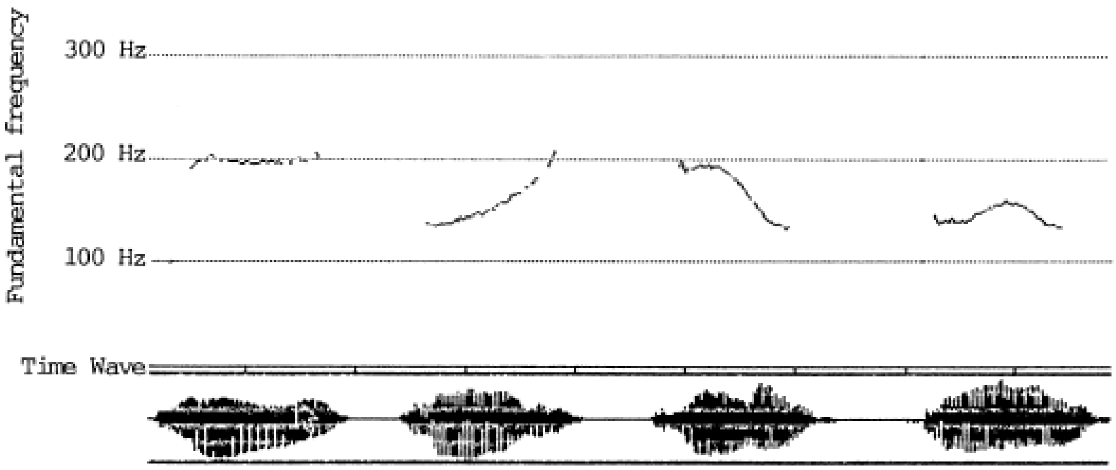


Figure 2: Pitch tracks of four monosyllabic words in Kairi *mó* ‘bow’, *mǒ* ‘tree species’, *mê* ‘before’and *mě̂* ‘do it!’(Newman & Petterson 1990:50)

In the pitch tracks given in figure 2, the only deviation from a canonical realization of the tonal patterns may be the pitch for the peaking (LHL) pattern, whose pitch peak is not as high as the other high toned elements. This may very well be an effect of phonetic coarticulation.

In longer words (cf. (14)), the last syllable is still a special domain, because it always bears at least one high tone, sometimes as part of a contour tone. In contrast to monosyllabic words, in disyllablic words there is no contour with three tones on one syllable.

(14) Disyllabic words in Kairi

a.	hónó ‘clan’	b.	óró ‘mist’	c.	húní ‘termite’
d.	hònǒ ‘garden’	e.	òhǒ ‘tongue’	f.	pìkǔ ‘turtle’
g.	hónô ‘husk’	h.	órô ‘cheek’	i.	túhî ‘fear’
j.	hòmô ‘a poison’	k.	òrô ‘tidemark’	l.	tùhî ‘lid’
m.	ǎnâ ‘mother’	n.	àítâ ‘father’	o.	kǒhî ‘punishment’

The examples in (14a-i) correspond very closely to the examples in (13). In (14a-i), the last syllable has the same tone as the monosyllabic words in (13a-i), whith the penultimate bearing the same tone as the first tonal element of the second syllable.

The correspondence is less clear for the monosyllabic examples in (13j-l). Similar tonal patterns are found in (14j-l) as well as in (14m-o). Newman & Petterson (1990:59) describe the examples in (14)m-o as exceptional, but this might be rooted more in their theoretical analysis than in the actual empirical data, since he states that about 9% of the trisyllabic words follow this pattern and the bisyllabic words with this pattern include the common words for ‘mother’ and ‘father’.

In even longer words it becomes obvious that only the last two syllables are distinctive and that all the preceding syllables take the first tone of the penultimate syllable. The last two syllables display the same tonal patterns that can be found on disyllabic words (cf.(15)).

(15) Longer words in Kairi

a.	kírímá ‘fish species’	b.	kétépó ‘darkness’	c.	hárákánéá ‘prawn species’
d.	ɛ̀mɛ̀hǐ ‘breadfruit’	e.	hɔ̀wàrǐ ‘wallaby’	f.	ràràkàně ‘palate’
g.	éhénê ‘fight’	h.	hákánê ‘grasshopper’	i.	pépéhérô ‘peg’
j.	kàtàmî ‘a morning’	k.	àràwê ‘post’	l.	àràmèráù ‘basket type’
m.	kàkǐhâ ‘bamboo species’	n.	ìmǐtî ‘clever’	o.	kàìtɔ́ùpî ‘type of song’

In the realm of morphophonology, there are several different ways of combining morphemes, whereas the output always follows one of the above patterns, except in certain types of compounds and reducplication, which will not be discussed here. Newman & Petterson (1990) describe several sandhi process as well as downstep processes. Unfortunately they neither distinguish phonetic downdrift from automatic downstep nor give examples for these processes on the word level. Since this thesis focuses on the word level, I will use the few examples they give for word level processes, even though they give more examples for the phrase level. The examples are given in (16).

(16) Examples of Tone Sandhi in Kairi (Newman & Petterson 1990:68)

a. ǐ + wɔ̀tú → íwɔ́tû
‘fire’ + ‘head’ → ‘firebrand, matches’

b. hě + tùhî → hètùhî
‘hand’ + ‘lid’ → ‘index finger and long finger’

c. hě + rô → hèrô
'hand' + 'rear' → 'little finger and ring finger'

d. hɔ̀ɛ́ + mɔ́ì → hɔ̀ɛ̀mɔ́ì
'wash' + NEG.FUT → 'will not wash'

In all examples in (16) the rising contour is simplified. In examples (16b-d) a rising contour in a simple word corresponds to a level low tone in the compound. In (16a) we see a more intriguing process: a HL and a LH stem are compounded and result in a word with all syllables high toned, except the last, which is falling.

(17) Adverbial Tone Sandhi

a. hâ + kɛ̀á → hákéá
'look' + 'upriver' → 'look upriver'

b. má + rɔ̀á → máróá
'sit' + 'downriver' → 'sit back'

c. hǎ + kɛ̀á → hàkèá
'throw' + 'upriver' → 'throw upriver'

d. kɛ̂ + kɔ̌ → kɛ́kɔ́
'up' + 'there' → 'up there'

Another tonal process, called Adverbial Tone Sandhi by Newman & Petterson (1990) is shown in (17). This process affects complex words consisting of at least one adverbial element of the closed class: *kɛ̀á* 'upriver', *kɛ̂* 'up', *rɔ̀á* 'downriver' and *rɛ̌* 'down'. The resulting word almost always bears only high tones, except when two rising toned syllables come together (cf. (17)). In this case, the resulting word has a low tone on the first syllable and a rising tone on the second syllable. This is especially interesting if we compare it to the example in (16a), where similar input tones result in a word that has high tones on all syllables except the last, which bears a falling tone.

All in all, we have seen that in Kairi there is a limited set of tonal melodies. Even though all syllables can occur with different tones, the tonal contrast is restricted to the last two syllables, since the tone of all other syllables can be easily predicted. If different morphemes are concatenated, the resulting complex word will bear one of the tonal patterns that are also found on simple words, albeit the concatenation of the same simple pattern may lead to different results.

2.3 Siane

Siane is a Trans-New-Guinea Language spoken in Papua New Guinea (Cahill 2011:6). The tone system in Siane is the most complex of all three languages. Its tone system has been analyzed and described in James (1994). Tone patterns are highly dependent on syllable count and in the case of bisyllabic words even on syllable weight. Affixes are either neutral or recessive, i.e. they never influence the stem.

Monosyllabic words can bear a high, low or rising tone (cf. (18)). Verbs never occur with only low tones.

(18) Monosyllabic words in Siane

a. nó
'to eat'

b. kò
'rain'

c. yǒ
'fire'

In bisyllabic words tone is also dependent on the moraic structure of a word. Both syllables contrast low and high tones. In addition there can be a falling tone on the first syllable or a rising tone on the second syllable, but never both. They are therefore mutually exclusive. The possible combinations are exemplified in (19).

(19) Bisyllabic words in Siane

a. kélá
'frog'

b. lónò
'work'

c. kêfá
'meat'

d. díyàú
'bright blue'

e. mèìnà
'payment'

f. màfó
'taro'

Interestingly, the falling-high and the high-rising tonal patterns (cf. (19c) and (19d)) are in complementary distribution. The high-rising pattern only occurs on stems with a diphthong in the second syllable, whereas the falling-high pattern never occurs in words with such a moraic structure.

No contour tones occur in words with three syllables or more. Again only a subset of all possible patterns are attested, in fact the number of possible patterns is smaller for trisyllabic words than it is for bisyllabic words. We never find patterns where the first two syllables bear the same tone and only the last syllable is different. In addition there is no low-high-low pattern. Examples are given in (20).

(20) Trisyllabic words in Siane

a. kétúfú
'saliva'

b. máfùnà
'owl'

c. kólìpá
'pine'

d. kòsìnà
'sky'

e. kìlífú
'trap'

A process that might serve as a connection between morphologically simple roots and complex morphological word forms is the so called phrase final lowering. At the right edge of a phrase words can only end in syllables bearing a low tone or a falling tone. This affects two kinds of words: words that form their own phrase and phrase final verb forms. These are the only place where we find falling tones on the last syllable. Examples are given in (21). This process should not lead us to believe that there are isolated monosyllabic words with falling tones.

(21) Words with phrase final lowering in Siane

a. ô 'yes'	b. ákê 'expression of surprise'	c. óf-áí-fê 'hit-3SG-Q'
d. mêl-áè 'put-3PL.IND'	e. mél-àì-fê 'put-3SG-Q'	f. éfì-n-ái-yê 'put-3SG-Q'
f. lèk-ái-fê 'break-3SG-Q'		

In general, suffixes in Siane are either recessive or neutral. Recessive suffixes do not change the pattern of the stems. Instead, the tones of the stem spread onto the affix, which causes simplification of contour tones if possible. This neutralizes the distinction between the falling-high and high-rising pattern on bisyllabic words (cf. (22g.-k.)). In (cf. (22)) several simple roots are shown with corresponding word forms, exemplifying the above explained processes.

(22) Recessive affixes in Siane

a.	ófó 'to hit'	b.	ófó-mó 'hit-1SG.REL'	c.	óf-én-áwá-mó 'hit-3PL-FUT-REL'
d.	mínò 'to remain'	e.	mínò-mò 'remain-1SG.REL'	f.	mín-én-àwà-mò 'remain-3PL-FUT-REL'
g.	kêfá 'meat'	h	kéfà-té 'meat-1PL.POSS'	i.	kéfà-káfó meat-ERG'
j.	ákàí 'harvest'	k.	ákàíy-ómó 'harvest-1SG.REL'		
l.	kò 'rain'	m.	kò-tè 'rain-1PL.POSS'	n.	kò-kàfò 'rain-.ERG'
o.	màfó 'taro'	p.	màfó-té 'taro-1PL.POSS'	q.	màfó-káfó 'taro-ERG'

(22f.) shows another process. If a word that starts with a high tone which is followed only by low tones has four syllables or more, the second syllable also becomes high toned. This process is similar to a process called 'Tone Doubling' in Makua (Odden 1995) and the tonal patterns in Kikuyu (Clements & Ford 1979). More examples for this process are given in (23).

(23) Tone doubling in Siane

a.	máfùnà 'owl'	b.	máfúnà-kàfò 'owl-ERG'	c.	máfúnà-mà-kàfò 'owl-DEF-ERG'
c.	lónò 'work'	d.	lónò-tè 'work-1PL.POSS'	e.	lónó-kàfò 'work-ERG'
d.	bálù 'care'	e.	báúl-àì-fà 'care-3SG-ADVERS'	f.	bálú-n-àwà-mò 'care-3PL-FUT-REL'

Neutral affixes on the other hand neither influence the tone of the stem nor do they adjust to the tonal specification of the stem. Instead they take their own tone, which also spreads to the following affixes. In addition they do not trigger simplification of contour tones. An example with the additive marker *tì* is given in (24).

(24) Opaque suffix *-tì* in Siane

a.	kêfá	b.	kêfá-tì	c.	kêfá-tì-mà
	'meat'		'meat-ADD'		meat-ADD-DEF

In this subsection we have seen that in Siane tone patterns are highly dependent on syllable count, ranging from three tonal patterns in monosyllabic words to six tonal patterns in a word with two syllables. In general, tonal contrast is restricted to the first three syllables. We have also seen additional patterns that can only occur at the end of a phrase and the difference between recessive affixes that take a tone of the stem and neutral affixes, which introduce their own tonal melody. We also saw another process in longer words, whereby an initial high tone is 'doubled' if it is only followed by low tones in a word of at least four syllables.

2.4 Interim summary

In the preceding subsections we have seen several interesting things that the three Trans-New-Guinea-Languages have in common. Apart from restricting the occurrence of contrastive tones to a clearly defined window at one edge of the word, no language prohibits more than one high toned syllable. This interpretation of the results might however depend on the analysis of the data, if cumulative H is understood as only one high tone per word (which might or might not be realized on more than one mora). Another similarity is that in Mee and Kairi all words have to bear at least one high tone. In Siane this is only true for verbs.
Mee is the only language of the three that does not allow contrastive tones on monomoraic words. This might be connected to the fact that the window for tonal contrast –the second mora– is not only extremly narrow, it is also outside of the scope of a monomoraic word. Kairi and Siane, which –with the last two and the first three syllables– have a much larger window also allow for a contrast on monomoraic and monosyllabic words. The results of the phonological comparison of the tone systems are summarized in the table in (25).

(25) Phonological comparison of the affix types in the tone systems

Language	Obl. H	Culm. H	Mono contrast	Position of contrast
Mee	✓	✗	✗	second μ
Kairi	✓	✗	✓	last two σ
Siane	(✗)	✗	✓	first three σ

On the morphophonological side we have seen that all of the three languages distinguish different kind of affixes. In Mee there is a distinction between dominant affixes, that trigger a change in the stem and neutrals affixes, that do not trigger a stem change. However, affixes are never influenced by stems other than through regular phonological processes. The exact opposite is true for Siane, where recessive affixes take the tone of the stem, whereas neutral affixes introduce their own tonal melody. In Siane affixes never influence the stems, which is the exact opposite of the generalization in Mee. The most complex description is that of Kairi, because both affixes and stems can change when concatenated. The resulting patterns seems to depend on the particular affix and the stem. The only pattern we never see is that of neutral affixes, where there is no influence in either direction. The results of the morphophonological comparison of affix types are summarized in (26).

(26) Morphophonological comparison of the tone systems

Language	Active	Recessive	Dominant	Neutral
Mee	✗	✗	✓	✓
Kairi	✓	✓	✓	✗
Siane	✗	✓	✗	✓

3 Theoretical framework

In the following section, I will describe the theoretical framework the analysis will be couched in. It is a version of Optimality Theory (OT) (Prince & Smolensky 1993), namely Colored Containment (CC) (van Oostendorp 2007) with a strict enforcement of the original Richness of the Base Principle (ROTB) and constraints based on the concept of Positional Markedness (de Lacy 2002, 2007). Each of the concepts will be explained in its own section.

3.1 Optimality Theory and Richness of the Base

Works rooted in autosegmental pre-OT phonology (Goldsmith 1976b) have often dealt with positionally restricted tone systems by either invoking very specific and seemingly arbitrary restrictions on the lexicon or even specifying a very limited set of possible tonal combinations for stems in the input, following the trend of that time to focus on underlying representations. A classical example is the analysis of tone in Mende (Mande; Guinea, Liberia, Sierra Leone) in Leben (1973) as cited in Goldsmith (1976a). There are four different underlying tone patterns, that cause different surface patterns depending on the syllable structure. Examples are given in (27).

(27) Example of restricted set of underlying representations in autosegmental phonology (Leben (1973) cited in Goldsmith (1976a))

a. Possible input patterns: H,L,HL,LHL

b. Association conventions: Associate the melody from left to right onto the segments.

c. Example Derivations:

(i)

H	→	H		H		→	H		
kọ		kọ́		pẹ	lẹ		pẹ́	lẹ́	

(ii)

H	L	→	H	L	H	L	→	H	L
mbu			mbû		ke	nya		ké	nyà

(iii)

L H L	→	L	H	L	L	H	L	→	L	H	L
mba			mbǎ̂		ni	ki	li		nì	kí	lì

(27) also shows the autosegmental representation of tone: segments and tone are on different tiers and formally independent of each other unless they are linked to each other by association lines. Language specific differences were explained by language specific rules and differences in the underlying forms. In the framework of Optimality Theory the optimal output candidate is selected by comparing all possible output candidates for a given input by a set of ranked violable constraints (cf. (28)).

(28) An example of a derivation in Optimality Theory

a. Input: abc

b. GEN generates all possible output candidates: abc, ab, bc, c, ...

c. set of strictly ordered constraints: $*a \gg *b \gg *c$

d. Evaluation of the candidates:

Input: abc	*a	*b	*c
i. ab	*!	*	
ii. bc		*!	*
☞ iii. c			*

Crucially, these constraints can only restrict the optimal output; they never restrict the possible input. Prince & Smolensky (1993:209) state, that "*all* inputs are possible in all languages. [emphasis in original]" and term this thesis Richness of the Base. If restrictions on the input are not allowed, the above shown solution to positionally restricted tone systems is not available. In this thesis I will show that it is possible to analyze positionally restricted tone systems without restriction on the input, using the same autosegmental representations that were used in pre-OT literature.

3.2 Coloured Containment and Prosodic Structure

Reference to prosodic structure in Optimality Theory reaches back to the original PARSE & FILL Model, suggested in Prince & Smolensky (1993). In this theory, deleted segments are modeled as not being incorporated into the prosodic structure, whereas inserted segments are 'empty' prosodic positions. The basic idea is thus, that no element may be removed from the input, i.e. that the input is contained in every candidate. A more recent implementation of this model is Coloured Containment (van Oostendorp 2007). It is based on the idea of Consistency of Exponence (McCarthy & Prince 1993), which means that the morphological affiliation of phonological material cannot be changed. This restriction on GEN makes it possible for the phonology to distinguish between exponents of different morphemes and inserted material. Van Oostendorp uses the metaphor of morphological *color* for the morphological affiliation of phonological material. To pursue this theme further, epenthetic material is colorless, because it has no morphological color. As a consequence it is possible for constraints to only target colorless material, just as it is possible to target differences between colors. It is however not possible to interpret such colors in phonology, as the morphological information has become unanalyzable. Colored Containment in the version of Trommer (2011) adopts the notion of Containment and Stray Erasure, from the classical PARSE & FILL Model, i.e. phonological material is not deleted. Instead there is a typology of association lines, where a line is not pronounced if it is marked as phonetically invisible. Epenthetic association lines are also different from underlying ones in a parallel fashion to the distinction between other epenthetic and underlying material. The typology of association lines is summarized in (29).

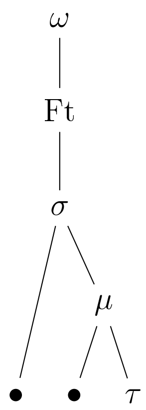
(29) Typology of association lines in Trommer (2011) (slightly modified)

	phonetically visible	phonetically invisible
underlying (=colored)	$\vert$	ǂ
epenthetic (=colorless)	$\vert$	ǂ

Phonological material not integrated under the highest prosodic node via a phonetically visible association line is not pronounced, which makes it necessary to consider the prosodic structure one assumes.

I will assume a classic autosegmental hierarchical prosodic structure that can be seen in (30). Almost all prosodic nodes can only dominate a specific kind of prosodic nodes and vice versa. Since this thesis focuses on word level processes, the highest prosodic node is always the prosodic word, which in turn dominates a foot. Feet can only dominate syllables, whereas syllables can dominate both moras and segmental nodes. Segmental nodes can also be dominated by moras, which distinguishes onset segments from nucleus and coda. This is the only exception from the otherwise strict harmony. Tones on the other hand can only associate to moras.

(30) Prosodic structure of a prosodic word



3.3 Constraints and Positional Markedness

My constraint set will mostly consist of structural and positional markedness constraints. Positional markedness constraints for tone are described in de Lacy (2002), whose system I will modify. De Lacy's system follows a certain scheme: prosodic structures and stress are enforced by certain constraints and tone is protected by faithfulness constraints. Since tone and stress interact in predictable ways, he proposes the following constraints in a fixed ranking (cf. (31)).

(31) Fixed ranking of Positonal Markedness Constraints on Tone (de Lacy 2002:2)

a. *FootHead/L $\gg$ *FootHead/M
b. *Non-FootHead/H $\gg$ *Non-FootHead/M

These constraints are based on markedness scales and relate certain tones to certain positions in a foot. The basic scheme is: 'count one violation for every tone X on a constituent Y.' The main distinction is headedness, because stress and tones are related. Since in the languages at hand there is no obvious sign of stress in terms of differences in vowel or consonant quality (Hyman 2009:217), I will omit this detail. Mid tones do not occur in these languages. Another difference is that constraints will make direct reference to prominent positions, instead of relating tone indirectly to prominent positions by prosodic structure and stress. A list of prominent positions can be seen in (32), taken from the list of prominent anchor points for affixes in Fitzpatrick (2004).

(32) Prominent word-level positions for positional markedness constraints (Fitzpatrick 2004)

a. initial mora ($\#\mu$)
b. initial syllable ($\#\sigma$)
c. initial foot (#Ft)
d. final mora ($\mu\#$)
e. final syllable ($\sigma\#$)
f. final foot (Ft#)

In addition I will reformulate these constraints to fit into the scheme of minimal association put forward in Trommer (2011), which means that they will also be defined positively, following Yip (2002:99). Generally such constraints demand the association of a certain node with at least one other node of a certain type. The scheme for Positional Markedness Constraints on Tone in Minimal Association will be: 'Count one violation for every tone X, that is not associated to a prominent prosodic constituent Y.' This gives us the constraints in (33).

(33) Positional Markedness Constraints on Tone .

a. $\mathrm{H}\rightarrow\#\mu$
Count one violation for every high tone that is not associated to the first mora of a prosodic word.
b. $\mathrm{H}\looparrowright\#\sigma$
Count one violation for every high tone that is not indirectly associated to the first syllable of a prosodic word.
c. $\mathrm{H}\looparrowright\#\mathrm{Ft}$
Count one violation for every high tone that is not indirectly associated to the first foot of a prosodic word.
d. $\mathrm{H}\rightarrow\mu\#$
Count one violation for every high tone that is not associated to the last mora of a prosodic word.
e. $\mathrm{H}\looparrowright\sigma\#$
Count one violation for every high tone that is not indirectly associated to the last syllable of a prosodic word.
f. $\mathrm{H}\looparrowright\mathrm{Ft}\#$
Count one violation for every high tone that is not indirectly associated

to the last foot of a prosodic word.

Crucially, these constraints have to make reference to indirect association (written as $\looparrowright$). Since tone can only be associated to moras in this model, I will make this notion explicit. Constraints can demand phonological elements to be associated to some prosodic unit that is dominated by a certain prosodic unit. Implicitly this concept has been used in a lot of well known constraints, most notably FootBinarity, which usually can refer to either syllables (direct association) or moras (indirect association). In contrast to de Lacy, I will also assume a general version of these constraints, which refer to all tones.
Another set of constraints will refer to boundary tones, that is tones that regularly occur at the edge of prosodic units without adding morphological information, i.e. these tones are no exponents of any morpheme. Since these constraints will require tones to occur on prominent positions (i.e. edges of prosodic constituents), they can be thought of as mirror images of the Positional Markedness Constraints on Tone. These constraints also make use of indirect association. Examples are given in (34).

(34) Examples of boundary tone constraints

a. $\#\mu \rightarrow$H
Count one violation for every first mora in a prosodic word, that is not associated to a high tone.

b. $\sigma\#\looparrowright$H
Count one violation for every last syllable in a prosodic word, that is not indirectly associated to a high tone.

Other constraints of minimal association will substitute for more general tonal constraints, e.g. $\mu \rightarrow \tau$ will substitute for the familiar Specify(T) and $\mu \rightarrow \tau$ for *Float(T) (Yip 2002). Furthermore I will use constraints on maximal association, again based on Trommer (2011). These will count violations for every phonological element X that is (indirectly) associated to more than Y instances of another type of phonological element Z. Examples of such constraints are given in (35).

(35) Examples of constraints on maximal association

a. $*\mu \rightarrow \tau_2$
Count one violation for every mora that is directly associated to more than one tone.

b. $*\text{Ft}\looparrowright \mu_3$

Count one violation for every foot that is indirectly associated to more than two moras.

The last set of structural markedness constraints are an implementation of other common constraints into Coloured Containment. These include constraints against rising and falling contour tones, as well as a constraint against colorless tones, i.e. inserted tones.

(36) Examples of other tonal markedness constraints

a. Dep(τ):
   Count one violation for every colorless tone.

b. $\sigma \not\hookrightarrow$HL (=*Fall):
   Count one violation for every syllable, that is associated to a sequence of a high and a low tone.

c. $\sigma \not\hookrightarrow$LH (=*Rise):
   Count one violation for every syllable, that is associated to a sequence of a low and a high tone.

4 Analysis

In the following subsections I will provide analysis of relevant data from the three Trans-New-Guinea languages. As the data and the relevant theoretical framework were introduced above, I will repeat important points only if necessary. Each subsection will introduce one important argument in favor of the superiority of an ROTB-based OT-analysis over a classical autosegmental approach with restrictions on the input. After introducing the argument, I will show that the ROTB based analysis is also able to derive the same data, that can be analyzed in a classic autosegmental account. I will conclude each subsection by showing the problems of a classic autosegmental analysis.

4.1 Mee

In the following subsection I will propose an analysis of Mee based on the straightforward implementation of surface true generalizations explained above into positional markedness constraints on tone and strict enforcement of Richness of the Base. This analysis will derive the basic phonological patterns as well as the morphophonological alternations. The basic idea is that the surface tonal pattern of a word are derived from the underlying specification and adjustement through markedness constraints.

The different behaviour of the stem can easily be accounted for, if we assume Richness of the Base. Stable pattern A_i stems will carry no high tone underlyingly, whereas unstable pattern A_{ii} stems will carry exactly one. Neutral affixes in context 1 will carry no high tone, as they do not cause any change, but dominant affixes in context 3 carry two high tones to enforce pattern B on any kind of stem. Affixes that carry only one high tone will cause changes only on some stems in context 2. A summary of the underlying representation is given in (37). A high ranked contraint relating high tones to the first bimoraic food will exclude candidates with more than two high tones and a boundary tone constraint for the first syllable will exclude words without high tones.

(37) Underlying tonal specifications of stems and affixes in Mee

A(i)	$\emptyset$	no high tone
A(ii)	H	one high tone
B	HH...	two or more high tones
Context 1	$\emptyset$	no high tone
Context 2	H	one high tone
Context 3	HH...	two or more high tones

We will continue the analysis by translating our generalizations straightforwardly into markedness constraints. We observed that all words in Mee have a high tone on their first mora, followed by a contrastive low or high tone, which in turn is followed by only low toned moras. High tones are thus restricted two the first two moras or more precisely: to the first preferably bimoraic foot. The corresponding constraints are formulated in (38).

(38) Basic constraints on Mee tone

a. $\#\mu \rightarrow \mathrm{H}$

Assign a violation for every first mora in a word, that is not connected to a high tone.

b. $\mathrm{H}\looparrowright\#\mathrm{Ft}$

Assign one violation for every high tone, that is not indirectly associated with the first foot.

c. $\mathrm{Ft}\looparrowright \mu_2$

Assign one violation for every foot, that is not indirectly associated with at least two moras.

d. $^*\mathrm{Ft}\looparrowright \mu_3$

Assign one violation for every foot, that is indirectly associated with three moras.

This gives us the simple patterns A and B, even if there are more or less tones in the input. It is important to assume, that the constraints against insertion and disassociation of low tones are low ranked. They thus become irrelevant to the analysis, because they are not phonologically active.

All possible combinations of stem classes and contexts are given in (39). Underlying forms are between slashes. Surface forms are in square brackets. Crucially the combinations where the underlying high tone count does not match the surface high tone count are excluded by constraints that are already high ranked in Mee. Toneless words are excluded by a the constraint $\#\mu \rightarrow$H requiring the first mora in a word to bear a high tone, which is violated by the most faithful candidate, if an A_i stem occurs in context 1. The combinations with more than two underlying high tones, e.g. B stems in Context 3, can never become optimal as such, since the high ranked constraint H↬#Ft penalizes high tones, that are not indirectly associated to the first foot in a word. Here the indirect association becomes crucial, because the high tones have to be directly associated to a mora, which has to be associated to a syllable associated to a foot to satisfy the constraints. The complex patterns involving pattern A_{ii} stems and context 2 are elegantly accounted for by the combination of underlying high tones.

(39) Possible Combination of stems and affixes in Mee

	Context 1	Context 2	Context 3
A_i	/∅/+/∅/	/∅/+/H/	/∅/+/HH/
	[H]	[H]	[HH]
A_{ii}	/H/+/∅/	/H/+/H/	/H/+/HH/
	[H]	[HH]	[HH]
B	/HH/+/∅/	/HH/+/H/	/HH/+/HH/
	[HH]	[HH]	[HH]

An example tableau for the form *bádò=kàà* 'with a foot', which has an input without any high tones is given in (40). The most faithful candidate candidate a. fails to satisfy the boundary tone constraint $\#\mu \rightarrow$H, which requires a high tone on the first mora. Candidate c. which bears two high tones is excluded by the insertion of another high tone, which is one more than candidate b. which only bears one high tone and is thus pattern A. The constraint $\mu \rightarrow \tau$ also excludes candidates that only have an initial high tones and no other tones, i.e. **bádo=kaa*. Crucially the DEP(H) constraint is ranked higher than the DEP(L) constraint, so that colorless high tones are preferred over colorless low tones. A constraint that is not mentioned in the table even though it is high ranked is the maximal association constraint $*\text{H}\rightarrow \mu_2$, which prohibits high tones connected to more than one mora. Since I assume that this constraint is never violated in Mee, I will ommit it in all following tableaux. The $\text{H}\hookrightarrow\#\text{Ft}$ constraint did not yet play a crucial role here, but it will if we look at other data, it will become obvious that this constraint is needed.

(40) Example derivation of a boundary tone in Mee

Input=a.	$\#\mu \rightarrow \text{H}$	$\mu \rightarrow \tau$	DEP(H)	DEP(L)
a. bado kaa	*!	* * **		
☞ b. H L: ba do ka a (H–ba; L–do, ka, a)			*	*
c. H H L: ba do ka a (H–ba; H–do; L–ka, a)	*		**!	*

We will continue by having a detailed look at one of the stem affix combinations that underlyingly have to much high tones. A possible example derivation for *áwí-tòògà* 'put into.FUT$_1$.DEF'is shown in (41). Here the footing of the candidates will become important.

(41) Example derivation of high tone deletion in Mee

Input=a.	$\mathrm{H} \looparrowright \#\mathrm{Ft}$	$*\mathrm{Ft} \looparrowright \mu_3$	$*\mu \rightarrow \tau_2$	$*\mathrm{H} \rightarrow \mu$
a. H H H H H / a wi to o ga	*! * * * *			
☞ b. H H H H H L / (a wi) to o ga				* * *
c. H H H H H L / (a wi) to o ga			*!	**
d. H H H H H / (a wi to o ga)		*!		

To save space I will indicate feet by parenthesis and all feet but the first are omitted. In addition the constraints governing feet placement will be omitted, except for the ones ensuring foot binarity. Candidate a., the most faithful one, has no foot at all and thus satisfies the constraint against ternary feet vacuously. It does not become optimal though, because every high tone counts as a violation as it's not associated to a mora, whose dominating syllable is associated to the first foot, since there is no first foot. These also shows that just inserting a foot would only reduce not eliminate the violations of this constraint. This constraint can, however be satisfied in several ways. One way is to expand the foot over the whole word as seen in candidate d. This incurs a violation of the maximal association constraint on feet $*\mathrm{Ft}\rightarrow \mu_3$, which keeps this candidate from becoming optimal. In candidate c., a low tone is inserted and spreads over the last two moras. The third high tone is saved by associating to the second mora, so that there is no violation of $\mathrm{H} \looparrowright \#\mathrm{Ft}$. Apart from violating the constraint $*\mathrm{H}\rightarrow \mu_2$ it also violates the maximal association constraint for tones on moras $*\mu_2 \rightarrow \mathrm{H}$, which penalizes candidates that have more than one tone associated to a mora. This is why candidate b. can become optimal, even though three high tones are not associated to a mora. All moras but the first two are now low toned.
It is important to note that the constraints used in the account of the morphophonology above are the same that accout for the division into two patterns in simple words.

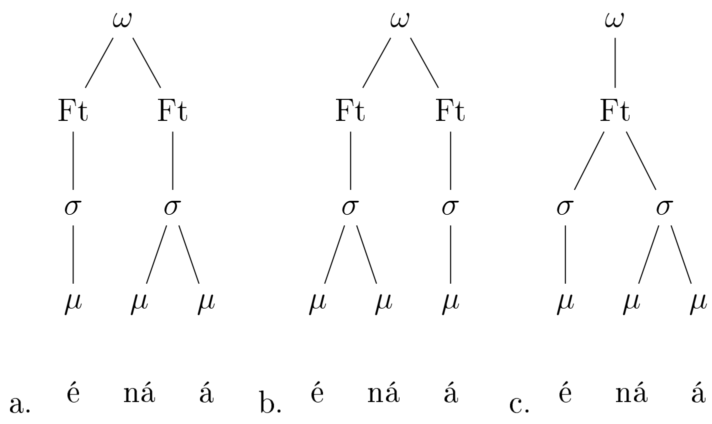
Regardless of the input the constraint ranking only allows words with either two high toned moras or one high toned mora at the left edge. In Tableau (42) we can see a derivation of the stem *máàkàdò* ‘true’ in isolation. It is assigned tone by exactly the same constraints used in the two tableaux above, even though the input is different. Also note that the number of low tones does not change the outcome of the analysis.

(42) Example derivation of an isolated stem in Mee

Input=a.	$\#\mu \downarrow \mathrm{H}$	$\mathrm{H} \downarrow \#\mathrm{Ft}$	$*\mathrm{Ft} \downarrow \mu_3$	$*\mu \downarrow \tau_2$	$*\mathrm{L} \downarrow \mu_2$
a. L H L L / ma a ka do	*!	*			
☞ b. L H L L / (ma a) ka do					*
c. L H L L / (ma a) ka do	*!				
d. L H L L / (ma a) ka do				*!	

Of the remaining issues, the most obvious one is the surface pattern B_2. Words which begin with a sequence of a light syllable followed by a heavy syllable bear high tones on the first two moras instead of the first two as one might expect. How can the analysis account for this fact? The first hint is visible if we have a closer look at the possible foot structures, that such a sequence can have. The assumption is, that a foot should either include more than one mora or less than three, preferably both. As you can see in (43), this gives us three possible foot structures. None of it can consist of two bimoraic feet.

(43) Possible foot structures for stems beginning in a sequence of light and heavy syllables.



In (43b.) we have an universally dispreffered structure. This is because we would either have to posit two identical adjacent monomoraic vowels or a bimoraic vowel that is associated with two different syllable. The former would instantiate a case of vowel hiatus, which is prohibited in Mee and a universally marked structure. The latter would produce an ambisyllabic vowel, which is also a rare structure in the world languages. I will exclude this footing with the abbreviated maximal association constraint $*\mathrm{V} \nrightarrow \sigma_2$, that ensures that vowels can be indirectly associated to only one syllable. This leaves us with the foot structures in (43a.) and (43c.). In the former the contrast between A and B would be neutralized, following the current analysis. Since we see a contrast on words with such syllable structures, we are left with the trimoraic and bisyllabic foot in (43c.). This is in accord with the assumption that high tones can only occur in the first foot. In (44) we can see how such a pattern can be derived for the word *énáá* 'ripe' by ranking constraints that we have already seen.

(44) Example derivation of foot structure in pattern B_2 words

Input=a.	$\mu \nrightarrow \mathrm{Ft}$	$\mathrm{Ft} \nrightarrow \mu_2$	$*\mathrm{V} \nrightarrow \sigma_2$	$*\mathrm{Ft} \nrightarrow \mu_3$
a. enaa	*!			
b. (enaa)				*
c. (ena)(a)		*!	*	
d. (e)(naa)		*!		

The undominated constraint against unfooted moras ensures the insertion of at least one foot and rules out candidate a, whereas the second constraint $\mathrm{Ft} \nrightarrow \mu_2$ is violated by both candidate c. and candidate d., since both feature a monomoraic foot. The third constraint $*\mathrm{V} \nrightarrow \sigma_2$ is not active in this derivation, but it would become important with longer words, where the monomoraic foot of candidate c. could possibly be expanded to a bimoraic foot. It would thus no longer violate the constraint Ft$\looparrowright \mu_2$, but still be excluded by the constraint against ambisyllabic vowels. The constraint *Ft$\looparrowright \mu_3$ can now be violated by the optimal candidate in b. to satisfy the the higher ranked constraints. This results in a trimoraic bisyllabic foot.

We have now made sure, that it is possible for a high tone to be associated to the third mora, but we have not yet excluded the possibility of a contour tone on the second syllable, e.g. **énáà*. I will account for this by the very general constraint *Contour and a positional faithfulness constraint. The former is a cover constraint for the more specific markedness constraints against rising and falling tones on syllables *$\sigma \looparrowright$LH and *$\sigma \looparrowright$HL. The later protects contour tones on the first syllable, where we still see them in pattern A stems, by protecting low tones in the first syllable. The constraint definitions are given in (45).

(45) Constraints for exemptional pattern B_2

a. $*\sigma \looparrowright \tau_i\tau_j$ (=*Contour)

Count one violation for every syllable that is associated to a sequence of two different tones.

b. $*\#\sigma \rightarrow \mu \blacktriangleright \text{H}$ (=Dep(H)$_{\#\sigma}$)

Count one violation for every mora in the first syllable that is phonetically associated to a high tone by a colorless association line.

It is very important how these constraints are ranked with respect to other markedness constraints.

(46) Example derivation of surface pattern B_2

Input=a.	$\mu \rightarrow \tau$	H ↬ #Ft	$\textsc{Dep}(\mathrm{H})_{\#\sigma}$	$*\sigma$ ↬ $\tau_i\tau_j$	$\textsc{Dep}(\mathrm{H})$
a. H H L / e na a				*!	
b. H H L / (e na a)				*!	
☞ c. H H L H / (e na a)					*
d. H H L L / (e na a)		*!			
e. H H L / (e na a)		*!			

Obviously the positional faithfulness constraint has to be ranked higher than the *Contour constraint to protect the first syllable. However both have to ranked above the constraint Dep(H) against colorless High tones, to allow high tone insertion as a repair strategy for words with a contour tone on the second syllable. Since existing high tones should still be shifted to the first foot, the two constraints mentioned above have to be ranked below the positional markedness constraint H↬#Ft. As above the constraint demanding moras to be associated to a tone will be undominated. An example derivation is seen in (46). As the input already has a contour neither the unchanged candidate a. nor candidate b. with an inserted foot can become optimal. Spreading the low tone or inserting a new low tone to avoid the contour tone crucially involves disassociation of a high tone. As this high tone is in turn no longer associated to the first foot, H↬#Ft is violated. We are left with candidate c.. Here a high tone is inserted and the low tone disassociated, satisfying the constraint against contour tones, while still keeping the high tone on the second mora in the first foot.

Another big mystery has not yet been accounted for. Why are the effects of the dominant affixes in the combination of context 2 and stem class A_{ii} restricted to stems consisting of two light syllables. It might be worthwhile to take a look at words with other syllable structures in this context. Even though Hyman & Kobepa (2013) do not give examples for all of the possibilities, they state that all verbs with another pattern change to pattern B, whereas all nouns with another shape do not change at all. It might look promising to have an account based on locality for these data, but it gets more difficult to derive the same pattern for shorter and for longer words. As I do not attempt to give a full analysis of the grammar of Mee, I leave this question open for future research.

Other open questions mostly depend on the lack of data. Why are there no dominant nominal affixes that change all stems to pattern B? Why are there no neutral nominal affixes? These seem to be arbitrary gaps in the data, which might get filled if more data is elicited. An interesting prediction of this analysis is that two pattern A_{ii} stems should yield a pattern B word if they are compounded. The underlying high tone of the second noun would shift to the second mora of the first noun. Unfortunately there is not enough data on compounds in Mee to test this prediction. The only compound where we see a pattern B word resulting from two pattern A nouns is *íyópìyà* 'cassowary' from *íyò* 'feather, hair' and *píyà* 'wood'. I have not yet been able to confirm the status of both nouns as pattern A_{ii} by adding different nominal clitics, but the pitch tracks of the recording of a speaker of the Tigi dialect presented in figure 1 seem to point in this direction.

A classic autosegmental analysis of this data would face several problems. The first one concerns the two basic patterns. If we associate from left to right, we would expect the patterns HL and HHL, which violates a principle thought to be universal in early classic autosegemental phonology Leben (1973). The obligatory contour principle does not allow a sequence of identical tones in the input. This issue can be circumvented by using the asterisk as an accent diacritic as it was used in Goldsmith (1976a). Either the first or the second mora would carry an accent, which links to an underlying starred high tone followed by an unstarred low tone H*L. The generalization about the positional restriction would thus be lost, because the position of every single starred syllable has to be stipulated.

If we assume the general association conventions similar to the ones mentioned in section 3, we would run into another problem with the dominant affixes in context 2 and 3. If we assume left-to-right association we would expect forms such as *áwìtóóg*á under the assumption that affixes bear a high tone, because the second part of an accentual H*L cannot be deleted. If we deny the possibility for these affixes to carry tone, we would have to rely on morphologically induced spreading or accent change. Suppose there was a way to avoid this problem, for example by using a privative system of H* vs. $\emptyset$, we would still not be able to derive the whole pattern. If context 3 affixes would add a high tone to pattern A_i stems, why would they fail to do so with pattern A_{ii} nouns? If pattern A_{ii} stems change to pattern B in context 3, why would they not change at all in context 2? The only available solution for classic autosegmental phonology would be morphological diacritics to derive phonological patterns (one could call them inflectional classes, cf. Hyman (1981)) and language specific adjustment rules. In the present analysis these can be derived using richness of the base and independently motivated constraints. The reason is that more possible inputs would call for output constraints to restrict the patterns, so that the analysis does not overgenerate by deriving toneless moras and three or more high toned moras in a word.

In this subsection I have presented an analysis of the Mee tone system. It is based on Richness of the Base and positional markedness constraints for tone and boundary tone constraints, which can crucially make reference to indirect association. Foot structure and constraints on maximal association completed the account, which also correctly derives the morphophonological alternations. I have argued that this account is superior to classic autosegmental approaches, since it neither relies on an arbitrary set of possible inputs, nor does it use diacritical morphological features for phonological alternations and their exceptions.

4.2 Kairi

Different tone patterns resulting from the same surface patterns. -> Different underlying forms. constraint against *HLH (citecitecite), constraints against tones showing up on other places than last foot high tone on last syllable, high tones that are on the last syllable can be deleted because constraint cloning? ! tau->m2 low ranked

In isolation monosyllabic words never show up with a dipping tones, even though we have just seen that the assumption of helps us deriving morphophonological alternations. To ensure that these stems show up with a rising pattern, as they do in fact, we have to look for constraints that exclude other possible candidates. An example derivation is given in (47). As mentioned above *Ft$\looparrowright$ τ_4 excludes the most faithful candidate a. with a dipping toned syllable.

(47) Example derivtion of an isolated HLH stem

Input=a.	*Ft $\nrightarrow$ τ_4	*σ $\nrightarrow$ HLH	τ $\nrightarrow$ $\sigma\#$	*σ $\nrightarrow$ $\tau_i\tau_i$	*σ $\nrightarrow$ HL	*σ $\nrightarrow$ LH
a. H L H kεa		*!			*	*
☞ b. H L H kεa			*			*
c. H L H kεa			*		*!	
d. H L H kεa			*	*!		
e. H L L H kεa	*!			*	*	*

It is also important that a resulting falling tone does not become optimal. This is achieved by ranking the constraint against falling tones above the constraint against rising tones, which excludes candidate c.. Deleting the low tone violates the constraint *σ $\nrightarrow$ $\tau_i\tau_i$, which excludes sequences of identical tones indirectly associated to a syllable. It is modeled after a similar constraint *Twin (McPherson 2016) based on the Twin Sister Condition by Clements (1984:95), where it is used in a much broader sense than it's more original application for tones e.g. in Kisseberth (1981:78). It was usually assumed to trigger tone fusion. Here instead it will exclude tone deletion as a possible repair strategy to satisfy the undominated constraint against dipping tones. Insertion of another low tone to split up the marked HLH structure as shown in candidate e. is penalized by the maximal association constraint for tones in feet *Ft$\nrightarrow$ τ_4. This leaves the rising tone in candidate b. as the optimal candidate.

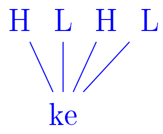
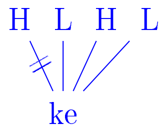
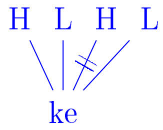
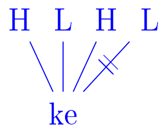
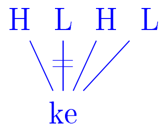
I will go on to show, that Richness of the Base does not cause any other problems when deriving the simple tone patterns in Kairi. As ROTB also produces toneless stems it is important to look at these. They can actually be derived very easily. As shown in (48), they can neither stay toneless nor become low toned due to the boundary tone constraint that demands a high tone on the last syllable. This excludes candidate a. and c. from becoming optimal.

(48) High tone insertion in Kairi

Input=a.	$\sigma\#$ $\looparrowright$ H	DEP(τ)
a. ke	*!	
☞ b. H | ke		*
c. L | ke	*!	*

Inputs with too many tones are also possible due to Richness of the Base. This is exemplified in (49). The most important constraint is the maximal association constraint *Ft$\looparrowright$ τ_4 against a foot being indirectly associated to four tones. This constraint causes candidate a. to not become optimal and allows minimal violation of the constraint $\sigma\#$ $\looparrowright$ against tones that are not associated to the last syllable. Disassociating the final high tone as shown in candidate d. does not solve the problem though, since it incurs a violation of the higher ranked constraint against dipping tones. Of the remaining candidates the ones in c. and e. feature sequences of identical tones, which violates the designated constraint *σ $\looparrowright$. The only remaining and thus optimal candidate bears a peaking tone on the only syllable.

(49) Tone delinking in Kairi

Input=a.	*Ft $\downarrow$ τ_4	$^*\sigma$ $\downarrow$ HLH	τ $\downarrow$ $\sigma\#$	$^*\sigma$ $\downarrow$ $\tau_i\tau_i$	$^*\sigma$ $\downarrow$ HL	$^*\sigma$ $\downarrow$ LH
a. 	$*$!	$*$			$*$	$*$
☞ b. 			$*$		$*$	$*$
c. 			$*$	$*$!	$*$	
d. 		$*$!	$*$		$*$	$*$
e. 			$*$	$*$!	$*$	

Recall the exceptional class of words, that end in a rising-falling sequence e.g. *ănâ* ‘mother’, which contrast with a default pattern, that ends in low-falling pattern. Until now underlying association has never played a crucial role in the analysis, but here it becomes crucial, since we derive two different patterns from an otherwise identical input.

(50) Example derivation of the default low-falling pattern

Input=a.	$*\text{Ft} \nleftrightarrow \tau_4$	$\tau \nleftrightarrow \text{Ft}\#$	$*\sigma \nleftrightarrow \tau_3$	$\tau \nleftrightarrow \sigma\#$	$*\sigma \nleftrightarrow \text{HL}$	$*\sigma \nleftrightarrow \text{LH}$
a. L H L / e hi ko		*!**		**		
b. L H L / e (hi ko)				**!		*
☞ c. L H L / e hi ko)				*	*	
d. L H L / e (hi ko)				*	*	*
e. L H L / e (hi ko)			*!		*	*!

An example derivation of *èhìkô* 'dish' is given in (50). Here we can also see the effect of the constraint $\tau \nleftrightarrow \text{Ft}\#$ in longer words, namely it requires tones to be linked to the last bisyllabic foot. It also excludes candidate a. which has no foot at all. Candidate b. violates the constraint $\tau \nleftrightarrow \sigma\#$, that demands tones to be associated to the last syllable, if this does not violate higher ranked constraints. In candidate e. all tones are linked to the last syllable, this does however violate the constraint against more than two tones aossciated to a syllable $*\sigma \nleftrightarrow \tau_3$. The only difference now between candidate c., the default pattern, and candidate d., the exceptional pattern, is that candidate b. has an additional marked contour tone, which causes candidate c. to become optimal.

(51) Example derivation of the exceptional rising falling pattern

Input=a.	τ ↓ Ft#	τ ↓ σ#	$*\sigma$ ↓ HL	$*\neq$	$*\sigma$ ↓ LH
a. L H L a na	*!**	**			
b. L H L (a na)		*	*	*!	
☞ c. L H L (a na)		*	*		*

How can the exceptional pattern ever become optimal, if it seems to be harmonically bounded by the default pattern? The answer, as mentioned above, lies in the underlying association lines that are generated randomly by GEN. If the high tone is already associated to the penultimate syllable, an exceptional pattern will arise. This is illustrated in (51). Another difference between the exceptional pattern in candidate c. and the default candidate in b. emerges now.In the default pattern we have to mark the underlying association line between the first syllable of the word and the high tone as phonetically invisible. This violates the designated constraint $*\neq$, which counts a violation for every phonetically invisible association line. Eventually candidate c. with the exceptional pattern will become optimal.

There are several problems for the autosegmental approach presented in Newman & Petterson (1990). Even to derive the simple tone patterns, they have to assume non-autosegmental tone copying from the penultimate to the last syllable. This derives pattern where for example the last syllable bears a falling tone, while the preceding one bears a high tone. This contrast with an otherwise strictly autosegmental accentual approach. In the present analysis it follows neatly from the interplay of several markedness constraints. The tone is shared between the two syllables to satisfy both the positional markedness constraints that demand tones to be associated to the last syllable and the boundary tone constraint that requires a high tone on the last syllable.
Though they do not have to invoke multiple possibilities for accented syllables they have to stipulate an exceptional class of words. Default accent is on the last syllable, whereas in the patterns claimed to be exceptional the accent is on the penultimate syllable. These words only occur with an LHL melody, which is another stipula-

tion. There are two different patterns derived from the same input tones. In the present approach these patterns are not exceptional at all, because the markedness constraint allow for a high tone to be shared between the last two syllables, which results in the accent pattern.
The most problematic part is again the morphophonology. Newman & Petterson (1990) again use a set of SPE-style rules to account for the results of the combinations of different melodies. These rules conspire to ensure words, that look as if they bear one of the simple melodies. This is more directly captured by a set of constraint, that applies to simple words as well as complex combinations. Surface true constraints unify the analysis of simple and complex words. The different results in combining morphemes with the same surface pattern are captured by Newman & Petterson (1990) by invoking semantically defined lexical classes. In the present analysis Richness of the base accounts for the possibility of underlyingly having an otherwise unattested HLH melody which only causes any effect in morphologically complex words. The contrast is thus neutralized in isolated stems.

All in all I have shown that the tonal morphology and morphophonology is easily derivable if one assumes surface true constraints and no restrictions on the input. Especially the otherwise unpredictable melodies when combining certain morphemes is explained by having a variety of input patterns. Another advantage over the earlier approach by Newman & Petterson (1990) is that the present one needs less exceptions.

4.3 Siane

Siane words have different tonal melodies depending on phonological factors like the number of syllables and the weight of certain syllables. In the following I will show, that this is easily derivable with surface true constraints. The most essential ingredient of the analysis is surprisingly simple. It is a maximal association constraint on syllable, that disfavors three tones on one syllable $*\sigma \nrightarrow \tau_3$. This drastically reduces the number of possible patterns for monosyllabic words. It is important to recall that falling tones only occur at the right edge of a phrase. I assume that the constraint against word final falling tones is in general ranked very high, but it is dominated by the low boundary tone constraint for phrases $\sigma\% \nrightarrow$L. This gives us three possible tonal patterns for monosyllabic words in non-final position.

(52) No falling tone on monosyllabic words in Siane

Input=a.	$\sigma\%$ $\not\to$ L	$^*\sigma\#$ $\not\to$ HL	τ $\not\to$ #Ft	*H $\to$ μ
a. H L no		*!	*	
b. H L (no)		*!		
☞ c. H L (no)			*	
d. H L (no)			*	*!

As you can see in (52) a falling tone in the input surfaces as low tone. Preceding the falling tone violates the designated constraint, whereas deleting the low tone does no become optimal due to the relatively low ranked constraint *H→ μ.

The most intriguing fact about bisyallbic stems is the alternation based on syllable weight. Here it becomes crucial that tones are still associated to a mora, even though constraints in the analysis of Kairi have only referred to syllables. The high-rising patterns only occurs on bisyllabic words whose first syllable is light, whereas the second one is heavy. This suggests that a constraint keeping moras from bearing two tones is still active in Kairi. We have already seen this constraint $^*\mu \to \tau_2$ in the analysis of Mee.

(53) Example derivation of an exceptional high-rising pattern on light-heavy word in Siane

Input=a.	$\tau \looparrowright \#\mathrm{Ft}$	$*\mu \rightarrow \tau_2$	$*\sigma \looparrowright \mathrm{LH}$	$*\sigma \looparrowright \mathrm{HL}$
a. H L H — di yau	*!	*		*
b. H L H — (di yau)		*!		*
c. H L H — (di yau)	*!			
☞ d. H L H — (di yau)			*	

As shown in tableau (53) deleting tones to satisfy the maximal association constraint for tones on moras is not allowed, since the constraints that requires tones to be associated to the first foot is ranked higher. This combination excludes candidate c. For both candidate a. and candidate b. violate the relatively high ranked constraint $*\mu \rightarrow \tau_2$, candidate d. becomes optimal, even though it features a rising tone, which is word internally more marked than a falling tone. The same ranking also accounts for the default pattern falling-high.

I will continue by showing that the general system in Siane can be derived with Richness of the base and surface true constraints. As we have already looked at monosyllabic and bisyllabic words, we will now look at longer words, where tones are restricted to the first three syllables. As in the other analysis above, the foot will be the prosodic constituent that restricts the position of tones. We have already established the constraint $\tau \looparrowright \#\mathrm{Ft}$, which in the analysis of mono- and bisyllabic protected tones from being deleted. In longer words it will eventually restrict the occurrence of tones to the first three syllable. That means that feet have to be ternary in some cases to explain patterns such as *kólìpá* 'pine'. I will assume a flat trisyllabic foot in these cases (contra e.g. Kager (1994)). The foot structure is easily predicted by having a maximal association constraint on feet $*\mathrm{Ft} \rightarrow \sigma_4$ ranked relatively high and the constraint $*\mathrm{Ft} \rightarrow \sigma_3$ ranked relatively low. Since it is the constraint that demands tones to be associated to a foot that will trigger the foot expansion, disyllabic feet still occur. Another constraint will play a crucial role here: the maximal association constraint for tones in feet $*\mathrm{Ft} \looparrowright \tau_4$ ensures that we never get more than three tones in a foot. In longer words this also prevents contour tones in combination with the constraint against contours on moras, since a trisyllabic foot will always have enough moras for three tones.

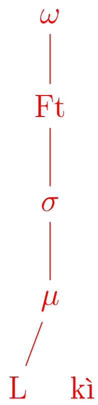
(54) Example derivation of a tenary foot in Siane

Input=a.	$*\mathrm{Ft} \looparrowright \sigma_4$	$\tau \looparrowright \#\mathrm{Ft}$	$*\mu \rightarrow \tau_2$	$*\mathrm{Ft} \looparrowright \sigma_3$
a. H L H / ko li pa		*!**		
☞ b. H L H / (ko li pa)				*
c. H L H / (ko li) pa			*!	
d. H L H / (ko li) pa		*!		

An example derivation of the word *kálìpá* 'pine' can be seen in tableau (54). Candidates a. and d. violate the constraint that requires tones to be associated to the first foot but for different reasons. Candidate a. has no foot at all, whereas in candidate d. a tone was disassociated and not reassociated, to allow a bisyllabic foot. Avoiding this disassociation by spreading the high tone into the first bisyllabic foot as shown in candidate c. violates the constraint against multiple tones on one syllable. This leaves us with candidate b. as the optimal candidate.

Concerning the morphophonological processes, I will assume that neutral affixes introduce their own phonological word, since we see exactly the same processes within a tonal domain opened by a neutral affix, that we have seen in combination of stems and recessive affixes. The underlying representation of a neutral affix is given in (55). To account for the recessive affixes in general I will assume, that root tones are protected by a special constraint, that demands root tones to be associated to some mora. To keep affix tone from entering the contrastive domain I will suggest a constraints that penalizes affix tones that are associated to moras in the first foot. This is necessary to prevent toneless stems from adopting the tonal melody of an affix. Instead a tone will be inserted. Since this is not central to the analysis, I will not show a fully detailed derivation here.

(55) Underlying representation of the neutral affix *kì* 'also'



Another phonological process that occurs in longer words is Tone doubling. It is clearly visible that this only happens in words with at least four syllables. One could assume, that there is a constraint against low tones being associated to the first foot, which can only become active if there is enough space for another foot in the word. There are several complication apart from this being the only case in the three languages where one explicitly needs a negative formulation of the positional markedness constraints on tone. In addition one would need a general constraint requiring high tones to associate to any foot in the word, which is again the only instance of a non-positional constraint of this kind that we have seen. Another important fact is that this process only occurs in morphologically complex words, because James (1994) does not give any three syllable stems. Because of these interacting and conflicting factors I will leave this question unanswered and open for future research.

This analysis also makes testable predictions. There should be a class of monosyllabic words, that change their pattern, if suffixes are attached to them. Curiously there is such a class of words, but James (1994) unfortunately only gives very few examples. These are connected to another supporting fact for this analysis. Under certain circumstances these 'exceptional'words are influenced by the grammatical context, which may be seen as an argument for specifying the affixes with tones, even if they do not show up normally. Examples are shown in (56). As you can see the rising tone melody that we see in the isolated stem, spreads as usual over the first two syllables in the FUT.1SG.REL, but in the 3SG.ADV we get a high-low-high pattern.

(56) Examples of alternating stems in Siane (James 1994:143)

	verb stem	FUT.1SG.REL	3SG.ADV
a.	fĩ 'to fight'	fìnúmó	fíyàìfá
b.	fũ 'to build'	fùnúmó	kúwàìfá

The most obvious problem for the classical autosegmental approach in James (1994) is the absence of a falling tone on monosyllabic words. That the assumed HL melody cannot associate to monosyllabic words is a pure stipulation. Even banning falling tones from the language does not help, since they occur on bisyllabic stems. This leads to another issue with their analysis.
Since he assumes the syllable to be the tone bearing unit, he has to invoke a complex language specific adjustment rule that reassociates a low tone on the final syllable if the conditions in (57) hold.

(57) Conditions for Low Tone Adjustment in Siane (James 1994:140)

a. The low tone is the first tone of the last syllable.
b. The number of tones on the last vowels exceeds the number of segments associated with the vowel.

The second condition can be reformulated if we assume the mora as the universal TBU. If there is more than one tone per mora on the last syllable, the low tone is shifted. This is easily captured in the present analysis by invoking a low-ranked constraint $*\mu \rightarrow \tau_2$. The first low tone of the last syllable is the only one that can spread without crossing association lines.

5 Conclusion

In the present thesis I have shown positionally restricted tone systems in three different Trans-New-Guinea languages. I have argued that it is possible to analyze these languages without restrictions on the input and even necessary to assume surface-true constraints. These constraints made reference to indirect association and related tones to prominent positions and vice versa. It turned out, that this approach did much better at deriving morphophonological alternations than an alternative classical autosegmental account. Surface true generalizations can be captured more directly without the need for conspiring language specific rules. Richness of the Base

allows us to do away with words and morphophonological processes that would have to be marked as exceptional in earlier accounts. The three main arguments where related to morphological and phonological criteria. In Mee and Kairi we have seen morphophonological tone changes that where easily describable due to richness of the base, but pose issues for a classic autosegmental approaches, because the underlying melody and/or the position of the accent would have to be changed.
In Siane we have seen that other phonological factors affect the possible tone patterns, like syllable count and syllable weight. This is easily captured by surface true constraints, but requires a set of language-specific tone adjustment rules in a classical autosegmental approach.

I have also compared the languages on the basis of surface true predesigned categories. If we put together the analytical and the typological part, several interesting generalizations emerge.
The contrast on monosyllabic/monomoraic words is directly tied to the maximal association constraints for tone. If the high ranked constraints restrict syllables or moras, a contrastive tone on monomoraic/monosyllabic words is impossible, as we saw in Mee. In Kairi and Siane on the other hand these constraints restricted the maximal number of tones in a *foot* to a number greater than one. This suggests that the presence of contour tones in shorter words and the possibility of contrastive tones on monosyllabic/monomoraic words are strongly tied in these three languages.
Another interesting relation can be seen between the position of the contrastive tone and the attested affix types. In Kairi we never see any neutral affixes. Looking at the position of the affixes and the position of contrastive tone it becomes clear, that this is because both the position of the affix and of the contrastive tone are on the right edge of the word. A neutral affix would thus violate the general surface true constraints in that language. In Mee and Siane on the other hand we see a set of neutral affixes, because they attach on the opposite edge of the word with regard to the contrastive tone.
The present approach also makes important cross-linguistic predictions. If a language has at least one high tone in a word, it should also be restricted to a certain position in a word, since there no constraint $\mathrm{H} \looparrowright \omega$, but only constraints that refer to specific prominent positions in a word. It also predicts that morphophonological processes in restricted tone systems should always add a tone and never delete all tones, because these processes are modelled as affixial tones being drawn to the prominent positions in a word.

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Eigenständigkeitserklärung

Hiermit versichere ich, dass ich die Hausarbeit selbstständig und nur unter Verwendung der angegebenen Hilfsmittel geschrieben habe. Alle Zitate sind als solche gekennzeichnet.

Ort, Datum — Unterschrift