Hiatus resolution in Formosan Austronesian and selected Bantu languages: A comparative analysis

by

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Declaration

I, Chen-Shu Fang, hereby declare that this dissertation submitted by me for a Master's degree in Linguistics at the University of the Witwatersrand is my own independent work that has not previously been submitted by me at another university or faculty. Therefore, I do cede copyright of this dissertation in favour of the University of the Witwatersrand.

方貞淑 10 Feb 2019

Signature Date

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Abstract

The aim of this study is to present a comparative analysis of common hiatus resolutions of a number of languages from the Bantu and Formosan Austronesian language families. Luganda, ciNsenga, ChiShona and isiXhosa belong to the Bantu language family, whereas Isibukun Bunun and Squliq Atayal belong to the Formosan Austronesian language family, that is, the Austronesian language spoken by aboriginals in Taiwan. The two language families are geographically distant from each other. However, due to the extent of coverage of Austronesian languages, Madagascar is the final point where Bantu and Austronesian language merge. Malagasy, the language spoken in Madagascar, is still categorized as one of the Austronesian languages, but it contains words of Bantu, Swahili, Arab, English, and French origin.

Although prior studies indicate that these languages have different phonological structures, they all disfavored hiatus (Huang, 2006; Casali, 2011; Kadenge & Simango, 2014; Rosenthall, 1997). Other previous studies (Busser, 2011; Kadenge, 2014; Park, 1997) that compare hiatus resolution using Optimality theory (OT) focus on the languages of the same language family or dialects of the same languages. This study thus aiming to compare the common hiatus resolutions two different distant language families. A vast corpus of ciNsenga, ChiShona, Luganda, isiXhosa, Isbukun Bunun and Squliq Atayal, with other supporting language data from Bantu and Formosan Austronesian languages, is drawn from the existing studies and presented in the analysis chapter. Glide formation occurs in all the selected languages. It is triggered when V_1 is high in ciNsenga, ChiShona, and Luganda. In addition, V_2 becomes a long vowel in Luganda after V_1 turns into a glide. Glide formation targets high vowels regardless of the position of V_1 or V_2 in Isbukun Bunun and Squliq Atayal. In isiXhosa, only a round V_1 before a following non-round vowel glides (/o+i/, /o+e/, /o+a/, /u+i/, /u+e/, and /u+a/) without a compensatory lengthening. Coalescence is not the hiatus repair strategy of ciNsenga and Luganda, but is one of the strategies to resolve hiatus in ChiShona, isiXhosa, Isbukun Bunun and Squliq Atayal. Coalescence takes place when the stem-final vowel and the following vowel are identical in both languages. In Squliq Atayal, when the stem-final vowel and the following –VC suffix create a falling-sonority sequence (a+u), coalescence is also triggered. Luganda has a similar strategy to deal with two juxtaposed vowels. However, it is categorized as Twin Vowel Deletion. Coalescence takes place in isiXhosa when V_1 is non-high and V_2 is high.

The overall findings of the study show that different rankings of the same set of constraints distinguishes one language from another, and also highlight the similarities between the two language families.

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Chapter 1: Introduction and Background

1.1 Introduction

This chapter introduces the study. It identifies the area of investigation, explains the objectives and justification of the research, presents the geographical backgrounds of the selected languages of the study, and outlines the structure of the research report.

1.2 Background to the Study

The term *vowel hiatus* refers to two adjacent vowel sequences occurring in different syllables with no intervening consonant in between. Many languages in the world do not tolerate hiatus, so strategies arise to resolve these successive vowel sounds. Hiatus resolution is found in Formosan Austronesian languages and Bantu languages alike. Formosan Austronesian languages are spoken by the aboriginals in Taiwan, and are part of the Austronesian language family, which spread widely throughout Maritime Southeast Asia, Madagascar and the islands of the Pacific Ocean. Formosan Austronesian languages have similar hiatus resolution strategies to Bantu languages, such as vowel elision, glide formation and coalescence. This is quite interesting since these belong to different language families, and the two language families are geographically far from one another. The present study will use existing data of two Formosan Austronesian languages—Isbukun Bunun and Squliq Atayal—and four Bantu languages—Luganda, isiXhosa, ciNsenga and ChiShona—to do a comparative analysis of their hiatus resolution strategies.

Isbukun Bunun and Squliq Atayal are two indigenous languages spoken in Taiwan. Isbukun Bunun is one of the main dialects of Bunun, and Squliq Atayal is one of the two dialects of Atayal. Bunun is spoken by 58,000 aboriginals who reside mostly in the central to southern part of Taiwan, while Atayal has about 89,000 speakers who live in the central to northern part of Taiwan (Figure 1). The number of speakers is relatively small in contrast with that of the Bantu languages selected for this study.

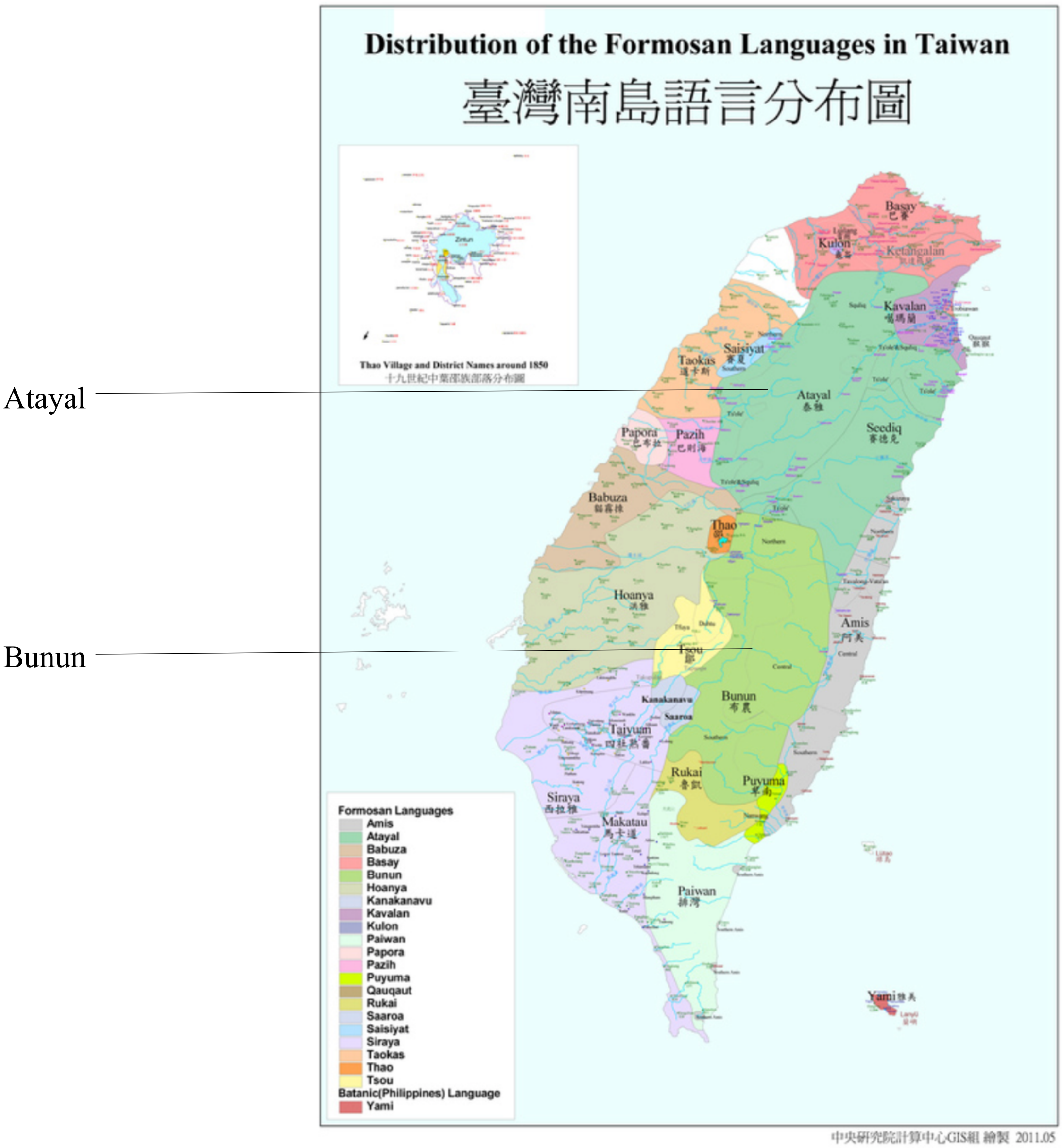

Figure 1. Map of Formosan Austronesian Languages (ACADEMIA Sinica Computing Centre, 2011).

The four selected Bantu languages are from Africa. Luganda is spoken by more than five million people in Uganda. IsiXhosa is the second most spoken language in South Africa, with about 8 million speakers. CiNsenga is spoken in the area around the Zambia-Malawi border, and ChiShona is spoken mainly in the Mashonaland provinces of Zimbabwe (Kadenge & Simango, 2014) (Figure 2). More detailed geographic backgrounds of these selected languages will be provided in the second last section of this chapter.

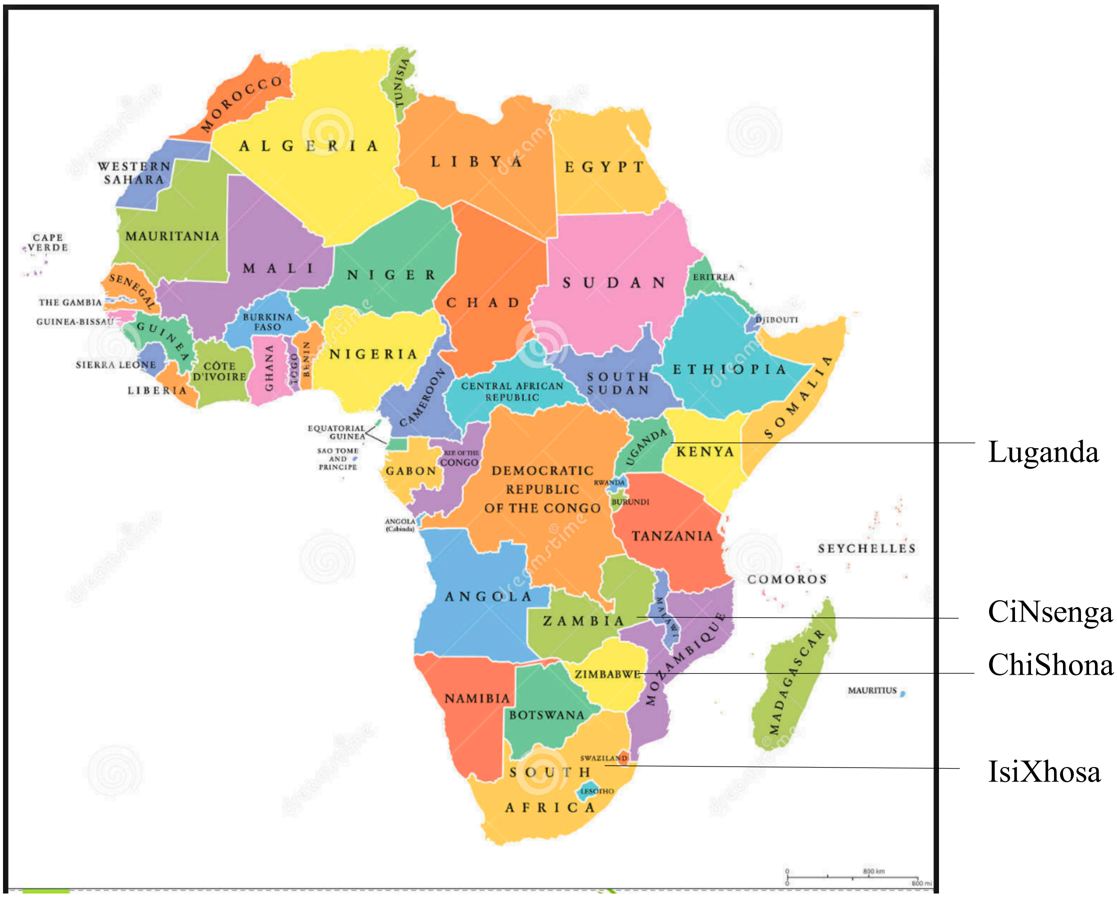

Figure 2. Map of the Distribution of Selected Bantu Languages (Dreamstime, 2018).

1.3 Area of investigation

Hiatus is a combination of two successive vowels occurring in adjacent syllables. In some languages, this combination is permitted, while in many others it is disfavored. Hiatus is restricted to certain phonosyntactical criteria of the language, and different resolutions are used to deal with such vowel sequences:

(i) vowel elision (deleting one of the vowels);

(ii) consonant epenthesis (inserting a consonant between two vowels);

(iii) glide formation (one of the vowels becomes a glide); and

(iv) coalescence the fusion form of two vowels.

Languages have different ways to resolve hiatus. Some languages have two strategies to do so, whiles others have three or more. Such diversity leads to the study of various topics in hiatus resolution within the investigation of the linguistic aspects of languages. Hiatus resolution has been studied extensively in Bantu and Formosan languages. Researchers (Harford, 1997; Park, 1997; Rosenthall, 1997; Rubach, 2000; Ola Orie and Pulleyblank, 2002; Lombardi, 2002; Picard, 2003; Huang, 2005, 2006, 2014; Sibanda, 2009; Kadenge, 2010, 2014, 2015; Mudzingwa, 2010, 2013; Rosendal, 2010; Yeh, 2011; Kadenge and Simango, 2014; Harford and Malambe, 2015; Khan, 2016; LI, 2015; Vratsanos and Kadenge, 2017) in this field have adopted Optimality Theory (hereafter OT) to demonstrate the comparison of phonological rules of languages and have revealed how different Bantu languages, or dialects of the same language, share the same set of rankings. It seems that OT analysis in these studies all focused on the same language family, or dialects of the same language to distinguish them from one another. Studies conducting comparative analyses of hiatus resolution within Formosan Austronesian and Bantu languages have not been found by the author. Since hiatus resolution in Formosan Austronesian languages exist, the present study aims, first, to thoroughly discuss the phonological rules these languages have for preventing vowel sequences; second, to investigate and contrast the OT constraints of hiatus resolutions; third, to discover the similarities and differences of resolving glide formation, coalescence and vowel elision in the selected languages; and lastly, to conduct a cross-examination of constraint rankings from different language groups. After all, the main focus of the study is to bring out the similarities of the two language families by using a comparative analysis of OT constraints.

1.4 Objectives of the study

The languages under investigation utilize the same hiatus resolution strategies. Glide formation occurs in Luganda, ciNsenga, ChiShona, isiXhosa, Isbukun Bunun and Squliq Atayal, while coalescence appears in ChiShona, isiXhosa, Isbukun Bunun and Squliq Atayal. Coalescence in Isbukun Bunun and Squliq Atayal seems like a straightforward vowel elision, but the process of hiatus resolution is more like the prevocalic distributions in Luganda. What is more, the coalescence of non-identical vowel final stems and vowel initial –VC suffixes in Squliq Atayal have the same resultant as those in Bantu languages such as isiXhosa and ChiShona. Therefore, the degree of similarity of hiatus resolution in Formosan Austronesian and Bantu languages is relatively high.

The objectives of the current study are:

(i) to present comparative analysis of the phonological rules of these languages based on their hiatus resolutions to discover their similarities and differences;

(ii) to compare hiatus resolution in selected Formosan Austronesia and Bantu languages, using OT.

1.5 Justification of the study

There are no known studies that compare repair strategies in Bantu and Formosan Austronesian languages. Also, it is uncertain if a cross-examination of hiatus resolution in both language families has been conducted. The present study offers a cross-linguistic examination of hiatus resolution of two Formosan Austronesian and four Bantu languages. Even though the phonological requirements of these languages are all different, they possess similar types of hiatus resolutions. Studies that adopted OT in the investigation of these languages all provide a complete set of constraint rankings to distinguish one language from another (Huang, 2006; Kadenge, 2014, 2015; Kadenge and Simango, 2014). The present study utilizes those existing constraints to conduct a cross-linguistic examination to test if constraints in a language of one language family are also applicable to another from a different language family. The cross-examination may not be a well-developed and thorough experiment from the empirical point of view, but the results of the study highlight the evidence that the hiatus resolutions of these selected Bantu and Formosan languages are highly similar. This finding could possibly lead to studies on a larger scale about the linguistic aspects of these two language families.

1.6 Brief Geographical Background of the Selected Languages.

1.6.1 Bantu and Formosan Austronesian Languages.

Bantu languages belong to the southern Bantoid group of the Benue-Congo branch of the Niger-Congo language family (Bendor-Samuel, 2017). Bantu languages are spoken in a very large area, including Central, Southeast and Southern Africa (Figure 3). Although the debates on languages and dialects are ongoing, there are an estimated 500 Bantu languages, and most of them are mutually intelligible (Rosendal, 2010).

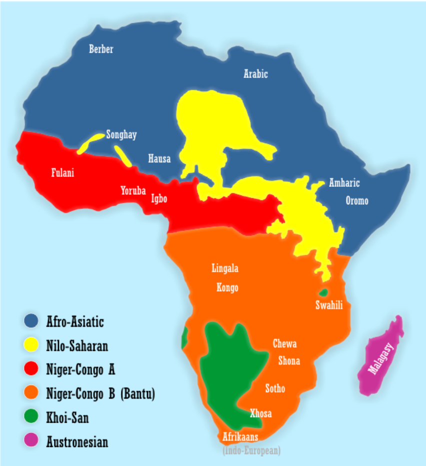

Figure 3. Languages in Africa (Mbamalu, 2017).

Figure 3 above presents the distribution of Bantu languages in relation to other African languages. It also shows an Austronesian language, Malagasy, which is spoken in Madagascar. The Austronesian language family is widely spread, including places such as Maritime Southeast Asia, islands of the Pacific Ocean and parts of continental Asia. There are different subgroups within the Austronesian language family. Formosan Austronesian specifically indicates the Austronesian spoken in Taiwan (Figure 4).

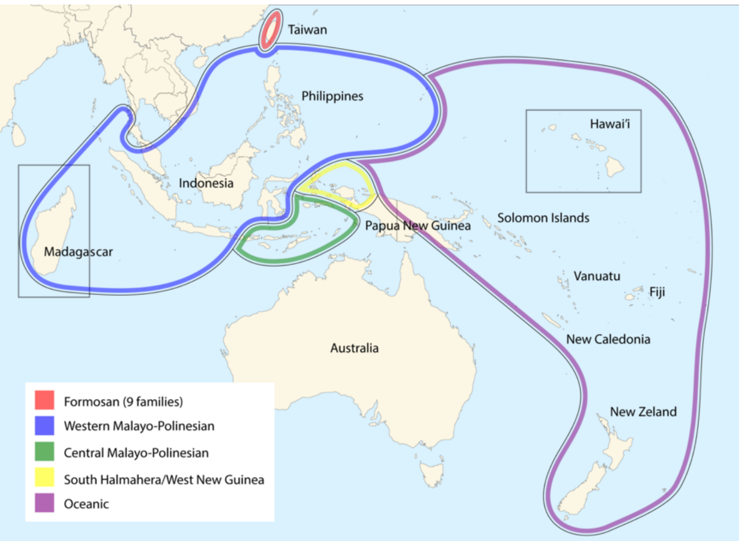

Figure 4. Distribution of the Austronesian languages (Blust, 1999).

Due to extensive migrations, Madagascar possesses great language diversity. Malagasy languages are grouped under Austronesian languages, but they contain words of Bantu, Swahili, Arab, English, and French origin (Augustyn et al., 2007; Blust, 2018). Madagascar is the final western immigration point of Austronesian languages, and also the place where the language family merges with Bantu.

1.6.2 Bantu languages: Luganda, ciNsenga, ChiShona, and isiXhosa.

CiNsenga and ChiShona belong to the southern Bantu branches. CiNsenga, also called ciNgoni, is the language of Ngoni people and is spoken around the districts of Chipata (Zambia) and Mchinji (Malawi) (Kadenge & Simango, 2014). CiNsenga is spoken by only three percent of the 11,126,922 total population of Zambia (2010 census), and is also spoken by 24,366 people in Malawi (2009 UNSD). ChiShona is spoken in Zimbabwe. The language belongs to the Southern Bantu group (Zone S10), according to Guthrie's classification (Guthrie, 1948). ChiShona comprises five dialects: chiKaranga, ChiZezuru, Manyika, Korekore, and Ndau (Mudzingwa, 2010). The variety of ChiShona analyzed by Kadenge and Simango (2014) is ChiZezuru, spoken in the Chikomba district of the Mashonaland East province, and this variety is used in the present study. Luganda, also known as Ganda, falls under the Bantu branch of the Niger-Congo language family and can be found in southern Uganda. Luganda is one of the major languages spoken by the Baganda ethnic group, about 5.56 million, which is the largest of nine ethnic groups according to the census of 2014 (Uganda Bureau of Statistics, 2014).

Due to the language diversity in Uganda, the majority of Ugandans are bilingual. Many of them are multilingual, meaning they can speak three, four, or five languages. When focusing on Luganda specifically, the number of Luganda L2 speakers is probably higher than L1, and some claimed to understand Luganda as their L3 or L4 (Rosendal, 2010).

IsiXhosa is one of the 11 official languages of South Africa. The language is part of the Nguni Bantu branch, with the most elaborate click inventories (Bostoen & Sands, 2012). IsiXhosa is spoken by 8,154,258 (2013 UNSD) L1 speakers, and they are considered the second largest cultural group, after Zulu speakers (11,587,374) (2013 UNSD). As in Uganda, the majority of South Africans are also bilingual or multilingual due to the country's language diversity.

1.6.3 Formosan Austronesian Languages: Isbukun Bunun and Squliq Atayal.

Bunun and Atayal are part of the Formosan Austronesian language family (Huang, 2006). With a population of 89,958, Atayal is the third-largest indigenous tribe in Taiwan, and Bunun is the fourth-largest indigenous tribe with a population of 58,336 (Table 1).

Table 1. Taiwanese aboriginal groups ordered according to population size (Council of Indigenous Peoples, 2017).

Tribe	Population	Tribe	Population
Amis	209,203	Tsou	6,635
Paiwan	100,591	Saisiyat	6,601
Atayal	89,958	Yami	4,599
Bunun	58,336	Kavalan	1,466
Truku	31,446	Sakizaya	930
Puyama	14,118	Thao	780
Rukai	13,303	Saaroa	398
Sediq	9,975	Kanakanavu	330
		Total	560,820

Bunun people live in the Central Mountain Range[1]. Initially, the tribe all lived in the Renai and Xinyi district of Nantou[2], the central part of Taiwan. With several great migrations, the Bunun gradually expanded their territory to the east, Hualine (花蓮), the south, Kaohsiu (高雄), and the mountain of Taitung (台東). Bunun is classified into five main dialects, namely Takituduh, Takibakha, Takbanuaz, Takivatan, and Isbukun. Isbukun Bunun is mostly spoken by Bunun people in a relatively wide region, including the central, southern, and eastern parts of Taiwan (Huang, 2005) (See figure 1).

The Atayal are the most widely spread tribes, even though the population is not the largest. The Atayal's settlement covers almost a third of the mountains of Taiwan, including both sides

[1] Also known as Chungyang Range (Chinese: 中央山脈), it is the main range of mountains in Taiwan that runs from north to the south of the island.
[2] Chinese: 南投縣仁愛鄉與信義鄉

of the main ridge of Xueshan Range[3] and the northern part of Central Mountain Range. The Atayal mainly live in the northern mountain area of Taiwan, but their territories are also widely spread. The tribes have expanded north to the Wulai District of New Taipei City (新北市烏來), south to Aowanda, Nantou County (南投縣奧萬大), west to Nanshi in Miaoli City (苗栗南勢), and east to the seacoast of the Pacific Ocean in Nan-ao, Yilan County (宜蘭縣南澳). Atayal has two dialects, Squliq and C'uli', the former of which can be found in the northern part of Taiwan (Huang, 2006), and is also the most spoken dialect of Atayal.

1.7 Structure of Research Report

This research report is composed of five chapters.

Chapter 1 provides a brief introduction to the study and simple geographic background of the selected languages. The chapter also discusses the area of investigation and outlines the aims of the study.

Chapter 2 gives the literature review of the study and identifies the knowledge gap that the present study aims to fill.

Chapter 3 provides the research methodology and the main scope of Optimality Theory (OT), which is the main theoretical framework of the study.

Chapter 4 first discusses the vocalic and consonantal inventories of the selected languages. The second part of the chapter introduces each of their hiatus resolutions, explains the OT constraints along with their phonosyntactical rules, and conducts comparative analysis focusing on three of the hiatus resolutions: glide formation, coalescence and vowel elision. A cross-examination of OT constraints amongst the selected languages is also presented in this chapter.

Chapter 5 concludes the study with a summary of the motivation and objectives, and the findings of the analysis. It also points out the empirical contribution of the research and proposes possible areas of further exploration.

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[3] One of the mountain ranges in Taiwan, also known as Snow Mountain Range.

1.8 Summary

This chapter has presented the focus of the study, the structure of the research report and the geographical background of the selected languages. The following chapter reviews previous studies on hiatus resolution that are related to the present research.

Chapter 2: Literature Review

2.1 Introduction

The previous chapter gave a concise introduction of the present study and of its aim of conducting a comparative analysis of hiatus resolution of selected languages from the Bantu and Formosan Austronesian language families. This chapter presents a detailed review in order to gain insight on previous studies of hiatus resolution of a selected number of Bantu and Formosan Austronesian languages and the theoretical framework of Optimality Theory (OT). The theory has been adopted to analyze phenomena such as hiatus resolution and minimality effects in different languages. Several scholars, including Park (1997), Casali (1997, 1998, 2011), Rosenthall (1997), Lombardi (2002), Ola Orie & Pulleyblank (2002), Picard (2003), Huang (2005, 2006, 2014), Sibanda (2009), Yeh (2011), Mudzingwa (2013), Kadenge & Simango (2014), Kadenge (2014, 2015), Harford & Malambe (2015), and Vratsanos & Kadenge (2017) have focused on the OT analysis of hiatus resolution, and minimality effects. These studies provide insight into the phonological rules and structures of both Formosan Austronesian and Bantu languages.

2.2 Review of Previous Empirical and Theoretical Studies on Hiatus Resolution Strategies

Vowel sequences arise from morphological or syntactic concatenation (Picard, 2003). Casali (1997, 1998, 2011) also states that one possible way to resolve ill-formed vowel sequences is to retain the sequence unchanged and syllabify the two vowels into separate syllables. However, many languages do not tolerate heterosyllabification, and thus undergo certain hiatus resolution strategies in response to ill-formed sequences (1).

(1). Strategies to resolve hiatus (Casali, 1998, p.3-4).[4]

a. Heterosyllabification: CV_1+V_2 > $.CV_1.V_2.$

b. Diphthong formation: CV_1+V_2> $.CV_1V_2.$

[4] V_1 = First vowel; V_2 = Second vowel.

c. Epenthesis: $CV_1+V_2>$ $.CV_1.CV_2.$

d. Vowel elision: $CV_1+V_2>$ $.CV_2(:).$ or $.CV_1(:).$

e. Glide formation: $CV_1+V_2>$ $.CGV_2(:).$

f. Coalescence: $CV_1+V_2>$ $.CV_3(:).$

It is quite common for a language to employ multiple hiatus resolution strategies. In the analysis by Casali (1997), large amounts of language data were used, revealing different strategies of hiatus resolution on V_1, V_2, and both V_1 and V_2. The study shows that, in most of the languages in the world, the target of the primary resolution of two adjacent vowels is V_1. Hiatus resolution that targets V_2 is also possible. What is more, different strategies function in different phonological and morphosyntactic contexts. The following subsections discuss each repairing strategy as set out in previous empirical studies.

2.2.1 Consonant Epenthesis

When a consonant is inserted as hiatus interrupter, it is called consonant epenthesis (Casali, 2011). Both Lombardi (2002) and Casali (2011) present glottal consonant [ʔ] epenthesis in their studies (2)–(3), and the former author claims that the glottal consonants [h] and [ʔ] are the most well-known cases of epenthesis. Lombardi also indicates that the empirical studies on coronals as epenthetic have been weak. However, her study shows that coronals also play a role, as epenthesis under certain constraints conflict (3).

(2). Glottal stop epenthesis in Selayarese (Lombardi, 2002, p. 226)

a. ku-ʔ-uraŋi	‘I accompany him’
ri-uraŋi	‘you (HON) accompany him’
b. ku-inuŋi	‘I drink it’
ri-ʔ-inuŋi	‘you (HON) drink it’

A glottal stop is inserted when two identical vowels appear. In contrast, glottal stop epenthesis is not triggered when hiatus is composed of two different vowels. This can be found in Malay when a CV prefix is attached to a vowel-initial root (3).

(3). Glottal stop epenthesis in Malay (Casali, 2011, p. 8).

a. /di-ubah/	[diʔubah]	'to change' (passive)
b. /sə-indah/	[səʔindah]	'to be as beautiful as'
c. /sə-elok/	[səʔeloʔ]	'to be as pretty as'
d. /di-olah/	[diʔolah]	'to beguile' (passive)
e. /di-aŋkat/	[diʔaŋkat]	'to lift' (passive)

Coronal epenthesis exists in few languages. Axininca Campa is commonly discussed, where the epenthetic /t/ always appears with suffixation, not prefixation (4). However, hiatus in prefixation triggers vowel elision.

(4). Coronal epenthesis in Axininca (Lombardi, 2002, p. 238)

a. /i-N-koma-i/	[iŋkomati]	'he will paddle'
b. /i-N-koma-aa-i/	[iŋkomataati]	'he will paddle again'

Example (4) shows that the coronal /t/ epenthesis is also caused by some phonological restrictions in Axininca. First, the language does not allow /ʔ/, and second, the language lacks /h/. This type of epenthesis has also been discovered in the study of Picard, who uses French data to represent the /t/ epenthesis (5).

(5). Coronal epenthesis in French (Picard, 2003, p. 4)

a. elle va	'she goes'	va-t-elle	'does she go?'
b. il joue	'he plays'	joue-t-il	'does he play?'
c. média	'media'	médiatiser	'to give media coverage to'

Another type of epenthesis is a semivowel, for example Ø⟶Y/__V [i,e] and Ø⟶W/__V [u,o]. In the study of five different hiatus resolutions of Shona, Mudzingwa (2013) presents this type of epenthesis (6).

(6). Consonant epenthesis/spreading in Shona (Mudzingwa, 2013, pp. 10–11).

Verbal word: Subject marker + object marker

a. /tà-ì-tòr-a/ [tàjìtòrà]

1PL.SM.PAST-OM-take-FV

'we took it'

b. /ʋà-ù-tòr-é/ [ʋàwùtòré]

2PL.SM.-OM-take-FV

'they should take it'

Verbal word: Negative marker + subject marker

c. /ɦà-ì-ɓát-ì/ [ɦàjìɓátì]

NEGJ-CL9.SUBJ-hold-FV

'it does not hold'

d. /ɦà-ù-ɓát-ì/ [ɦàwùɓátì]

NEGJ-CL1.SUBJ-hold-FV

'you don't hold'

Verbal word: Tense marker + object marker

e. /tì-nò-ù-ɗ-a/ [tìnòwùɗà]

1PL.SUBJ-HAB-CL9.OBJ-want-FV

'we want them'

f. /tà-kà-ì-ɗ-a/ [tàkàjìɗa]

1PL.SUBJ-PAST-CL9.OBJ-want-FV

'we wanted them'

Verbal word: Object marker + verb root

g. /ì-ón-e/ [ìwóné]

CL9.SG.-see-FV

'see it'

h. /ù-ón-e/ [ùwóne]

CL3.SG.-see-FV

'see it'

Verbal word: Subject marker + verb root

i. /tì-ón-é/ [tìwóné]

1PL.SUBJ.-see-FV

'let us see'

j. /mù-ù^{n}dùr-é/ [kùwù^{n}dùré]

CL1.SG.-pluck feathers-FV

'you should pluck feathers off'

Deverbal nouns:

k. /ít-á/ [ítá]

do-FV

‘do’

/mú-ít-í/ [mújítíí]

CL1.SG.-try-FV

‘the one does’

/ʋà-ít-í/ [ʋàjítí]

2PL.-do-FV

‘the doers’

l. /èd^{z}-a/ [èd^{z}a]

try-FV

‘try’

/mù-èd^{z}-ì/ [mùjèd^{z}ì]

CL1.SG.SUBJ-try-NOM

‘the one who tries’

/ʋà-èd^{z}-í/ [ʋàjèd^{z}í]

CL2.PL.-try-NOM

‘the ones who try’

m. /òn-à/ [ònà]

see-FV

‘see’

/mù-òn-í/ [mùwòní]

CL1.SG.-see-NOM

‘the one who sees’

/ʋà-òn-í/ [ʋàwòní]

CL2.PL.-see-NOM

‘the ones who see’

n. /ù^{m}b-à/ [ù^{m}bà]

mould-FV

‘mould’

/mù-ù^{m}b̀-ì/ [mùwù^{m}b̀-ì]

CL1.SG.-mould-NOM

‘the one who moulds’

/ʋà-ù^{m}b-ì/ [ʋàwù^{m}bì]

CL2.PL.-mould-NOM
'the ones who mould'

In the data above, Mudzingwa presents a type of semivowel epenthesis, that is, the homorganic glide is inserted instead of an entirely new segment. Examples (6a) to (6j) show the hiatus resolution between different verbal words: subject marker and object marker; negative marker and subject marker; tense marker and object marker; object marker and verb root; and subject marker and verb root. Examples (6k) to (6n) present hiatus resolution across class prefixes and deverbal stems. A common approach of consonant epenthesis is gliding that agrees in features with, mostly, a high vowel, while with non-high vowels, where a corresponding glide does not exist in most languages, a glottal stop is utilized to resolve hiatus instead (Lombardi, 2002). Thus, vowel hiatus is resolved via the epenthesis of a glottal stop ([ʔ]) or fricative ([h]). Casali (2011) concludes by proposing three types of epenthesis as follows (7):

(7). Three possibilities of consonant epenthesis (Casali, 2011, p. 7).

a. A semivowel, usually one that is homorganic with (i.e., shares the same frontness or roundness) the first vowel or the second vowel.

b. A glottal stop ([ʔ]) or fricative ([h]).

c. A coronal consonant, generally [t] or a rhotic.

(7) shows the different types of consonants that can be inserted to break up a sequence. It is known from the study of Mudzingwa (2013) that epenthesis is triggered in the verbal domain only in Shona. Other hiatus resolutions such as glide formation, secondary articulation, and elision are found in the nominal domain, and coalescence in the cliticisation domain. In the selected Austronesian languages of the present study, glide epenthesis is found in neither Isbukun Bunun nor Squliq Atayal. Instead, glide formation is one of the hiatus repairing strategies. The following section discusses how a hiatus is resolved by this type of strategy.

2.2.2 Glide Formation

Glide formation is another type of hiatus repair strategy and has been discovered in most of the languages selected for this study. In the study of prevocalic vowels, Rosenthall (1997) shows different distributions of prevocalic vowels using the data of Luganda, Etsoko, Yoruba, and Kimatuumbi. Yoruba undergoes vowel elision; Luganda and Etsako parse high prevocalic vowels and delete the non-high vowel (8–9); Kimatuumbi parses all prevocalic vowels, meaning vowel elision is not applicable.

(8). High Prevocalic Vowel Glides in Luganda (Rosenthall, 1997, p. 150)

/li+ato/	l^{y}a:to	'boat'
/ki+uma/	l^{y}u:ma	'metal object'
/mu+iko/	m^{w}i:ko	'trowel'
/mu+oyo/	m^{w}o:yo	'soul'

(9). High Prevocalic Vowel Glides in Etsako (Rosenthall, 1997, p. 162)

/alokui/	[alok^{w}i]	'chameleon'
/oθie/	[oθ^{y}e]	'king'
/du# akapa/	[d^{w}apka]	'carry a cup'

Above, (8) and (9) both show how a high V_1 glides in Luganda and Etsako. Unacceptable vowel sequences are also studied by Kadenge and Simango (2014), who use ciNsenga and ChiShona data to present a formal comparative analysis of hiatus resolution between two languages. The authors point out that repair strategies in resolving vowel hiatus are sensitive to phonological and morphosyntactical context. CiNsenga has three repair strategies, namely glide formation, secondary articulation, and vowel elision. ChiShona possesses five repair strategies: glide formation, secondary articulation, vowel elision, coalescence, and glide epenthesis. Therefore, both ciNsenga and ChiShona have glide formation as their primary hiatus resolution (10–11).

(10). Glide Formation in ciNsenga (Kadenge and Simango, 2014, p. 111).

/u-ako/	[wako]	'yours'
/u-eka/	[weka]	'only'
/u-o^{n}se/	[wo^{n}se]	'all'
/i-a$^{\text{ŋ}}$gu/	[ja$^{\text{ŋ}}$gu]	'mine'
/i-ake/	[jake]	'his'
/i-o^{n}se/	[jo^{n}se]	'all'
/i-eka/	[jeka]	'only'

(11). Glide Formation in ChiShona (Kadenge and Simango, 2014, p. 111).

/u-aᵑgu/	[waᵑgu]	‘mine’
/u-ega/	[wega]	‘alone’
/u-ose/	[wose]	‘all’
/i-aᵑgu/	[jaᵑgu]	‘mine’
/i-ake/	[jake]	‘his’
/i-ose/	[jose]	‘whole’
/i-eɗu/	[jeɗu]	‘ours’

Kadenge (2014) employs OT in the analysis to conduct a formal comparison of hiatus resolutions on two less well-studied dialects of ChiShona: chiNambya and ChiZezuru. He introduces three repair strategies for resolving hiatus in these two dialects, namely glide formation, secondary articulation, and vowel elision. The study provides more evidence of glide formation in ChiShona (12–13).

(12). Glide Formation in chiNambya (Kadenge, 2014, p. 63).

/mu-ojo u-aᵑgu/	[mojo waᵑgu]	‘my heart’
/mu-ono u-oga/	[mono wog̤a]	‘one fish trap’
/iɲuni i-e*d̤*u/	[iɲuni je*d̤*u]	‘our bird’
/iɲika i-aᵑgu/	[iɲika jaᵑgu]	‘my country’

(13). Glide Formation in chiZeruru (Kadenge, 2014, p. 63–64).

/mu-ti u-eɗu/	[muti weɗu]	‘our tree’
/mu-to u-aᵑgu/	[muto waᵑgu]	‘my soup’
/mi-ti i-ose/	[miti jose]	‘all the trees’
/mi-soro i-aᵑgu/	[misoro jaᵑgu]	‘my heads’

Glide formation is also presented in the study of Xitsonga by Vratsanos and Kadenge (2017). The study of this Bantu language is the first formal analysis of vowel sequence repair strategies in Xitsonga. The article considers four repair strategies: glide formation, secondary articulation, elision, and coalescence. Amongst these, glide formation is the primary strategy, in which /i/ and /u/ correspond to [j] and [w], respectively. Secondary articulation is the next choice when glide formation fails. Height coalescence exists in Xitsonga when /a +i/ → [e], and /a +i/ → [o]. Some limited language data of isiXhosa are also presented by Casali (2011, p. 18), who states that a rounded V_1 glides before a following non-round vowel. The studies discussed above present detailed analyses of different Bantu languages. Undoubtedly, vowel hiatus is disfavored in most of these Bantu languages. Moreover, these previous studies on Bantu languages all show the utilization of glide formation as the primary repair strategy when dealing with hiatus.

However, some studies have shown that Formosan Austronesian languages do not tolerate vowel hiatus either. Post-consonantal onglides in Isbukun Bunun are presented by Huang (2005), who also presents prevocalic glides in Squliq Atayal (Huang 2014). In Isbukun Bunun and Squliq Atayal, high vowels glide regardless of their position. In other words, V_1 glides if it is a high vowel, otherwise a high V_2 glides. This indicates that vowel height and place of articulation determine glide formation. Gliding can be blocked, first, when V_1 and V_2 share the same frontness and roundness, and second, when they are preceded by certain consonants. Example (14) shows that all consonants in Isbukun have been found to precede the glide except /h/ and /v/.

(14). Consonants that precede the onglides [j w] in Isbukun (Huang, 2005, p. 6)

	/i/ [j]		/u/ [w]	
/p/	mahulpiah	'thick'	puah	'flower'
/b/	labian	'night'	buan	'moon'
/t/	saitia	'he'	matua	'open'
/d/	madia	'many'	mainduduað	'young people'
/k/	ʔakia	'the statue of a god'	balikuan	'butterfly'
/ʔ/	mapitʔia	'cook'	pasiʔuaʔua	'wild ducks'
/v/	kaviað	'friend'		
/s/	mahansiap	'be good at'	masuað	'plant'
/ð/	busðiah	'broken'	laiðuan	'Saaroa'
/h/	N/A		patishuan 'firefly'	
/m/	miahan	'the day after tomorrow'	masmuav	'very'
/n/	hanian	'day'	bunuað	'plum'
/ŋ/	taŋia	'ear'	tanbuŋuan	'pillow'
/l/	muliahliah	'tear apart'	ʔaluað	'mouse'

Both hj- and vw- syllables are missing, but hi- and vu- are found in Isbukun. This suggests that no occurrence restrictions exist between /j/ and /w/ onglides and the preceding consonant. Huang (2005) indicates that hj- and vw- syllables in this language are simply rare. What is more, to account for the hiatus with the same frontness and roundness, no ji- and wu- sequences are found in Isbukun either.

Both Huang's articles (Huang, 2005, 2014) employ OT in the analysis of glides and provide detailed descriptions of the constraints in these two Formosan Austronesian languages. For a comparative analysis of vowel hiatus resolution in Isbukun Bunun and Squliq Atayal, Huang (2006) provides a thorough discussion of similarities and differences between repair strategies, namely glide formation and coalescence. Yeh (2011) introduces vowel hiatus resolution in Paiwan, another Formosan Austronesian language, and gives a detailed discussion of Paiwan phonology and hiatus resolution: glide formation and coalescence.

(15). Glide Formation after Suffixation in Paiwan (Yeh, 2011, p. 72).

/kəvava-i/	[váj]	'drink wine'
/pu-vasa-u/	[sáw]	'add taro'
/t͡sapa-u/	[páw]	'roast!'
/kat͡su-i/	[t͡súj]	'carry'
/p<in>uɖu-an/	[ɖwán]	'have abscess (irrealis)'
/ʀa-ʀuvú-an/	[vwán]	'places where can be nest'
/qinipu-áŋa/	[pwá]	'have been filled with soil'
/qaɭuvu-i/	[vúj]	'to disorder something! (imp.)'
/sajgu-aʔən/	[gwá]	'I can'
/vaʎi-u/	[ʎíw]	'put board (imp.)'
/pu-vuʀasi-an/	[sján]	'fields of sweet potato'
/pu-ɭapi-an/	[pján]	'locations where hollow grains were put'
/nasi-u/	[síw]	'breathe! (imp.)'
/namasanə-sizi-aŋa/	[zjá]	'has become sheep'
/səma-gadə-aʔən/	[də̆á]	'I climb the mountains'
/təməzə-aʔən/	[zə̆á]	'I hiccup'

In general, based on the analyses of Huang and Yeh, the three Formosan Austronesian languages have the same hiatus resolution strategies. They also all have glide formation as one of their hiatus resolutions, which is identical to the above-mentioned studies on Bantu languages.

Thus far, it is known that glide formation is the primary hiatus repair strategy. Also, identical vowel sequences fail to undergo glide formation, and a low V_1 rarely triggers glide formation. In such cases, vowel elision or coalescence is activated in these syllables. The following subsections explain these two hiatus resolutions further.

2.2.3 Vowel Elision

Vowel elision refers to the deletion of either V_1 or V_2 in the case of vowel sequences (Casali, 2011). The elision of V_1 or V_2 is constrained by phonological, morphological, or syntactic rules (Casali, 1997). In other words, the elision of V_1 and V_2 is subject to certain morphosyntactic restrictions. In most of the world's languages, the target of the primary resolution of two adjacent vowels is V_1, though hiatus resolution that targets V_2 is also possible. The choice of vowel is not random, but determined by the constraints of each language. For instance, V_2 elision can be found in the following cases (16).

(16). V_2 elision (Casali, 2011, p. 9)

a. The boundary between a lexical (content) word and the following function word.
b. Stem-suffix boundaries.

The relationship between vowel elision and morphosyntactic position is better explained in Table 2.

Table 2. Vowel elision and morphosyntactic position (Casali, 2011, p. 10)

Context	Robustly attested possibilities
Between two content words	V_1 elision
Content word before function word	V_1 elision or V_2 elision
Prefix + root	V_1 elision
Root + suffix	V_1 elision or V_2 elision

It is clear from the table above that morphosyntactic context determines which vowel remains. V_1 elision can be found in all the morphosyntactic positions while V_2 elision only occurs in two positions. Examples of V_1 elision are presented by Rosenthall (1997) in the study of prevocalic vowel distribution (17)–(18).

(17). Vowel elision in Luganda (Rosenthall, 1997, p. 155)

a. /ka+oto/	[ko:to]	'fireplace (dim.)'
/ka+ezi/	[ke:zi]	'moon (dim.)'
/a+tem+eo+mu+ti/	[atemo:muti]	'let him cut the tree'

In (17) it is shown that the prevocalic non-high vowel is deleted in Luganda. Etsako has the same prevocalic distribution as Luganda, and high vowel glides and non-high vowels are deleted (18).

(18). Vowel elision in Etsako (Rosenthall, 1997, p. 162)

a. /dɛ # akpa/	[dakpa]	'buy a cup'
b. /sese # akapa/	[sesakpa]	'make a cup'

Both Luganda and Etsako have different distributions for prevocalic vowels depending on the highness of V_1. Yoruba has a different repair strategy, namely that when hiatus occurs in an affix, verb or preposition, V_1 is deleted (19).

(19). Vowel elision in Yoruba (Ola Orie & Pulleyblank, 2002, p.102).

a. owó kí owó money any money	owókówó	'any money at all/bad money'
ọmọ kí ọmọ child any child	ọmọkọ́mọ	'any child at all/bad child'
b. se olú cook mushrooms	solú	'cook mushrooms'
jẹ edé eat shrimp	jedé	'eat shrimp'
jó ẹ̀wù burn clothing	jẹ́wù	'burn clothing'
ra ọ̀gẹ̀dẹ̀ buy banana	rọ̀gẹ̀dẹ̀	'buy bananas'
ní oko at farm	lóko	'at the farm'
sí ọjà to market	sọ́jà	'to the market'

Yoruba uses vowel deletion and assimilation to solve hiatus. In the cases when a vowel sequence involves nouns, vowel assimilation is triggered. In other words, unlike Luganda and Etsako where the resolution is due to phonology, the distinction between the two resolutions is due to the morpho-syntax, which is illustrated in the study by Casali (2011) on the relationship between vowel elision and morphosyntactic positions. Such a relationship also appears in ciNsenga and ChiShona, although vowel elision is least preferred in these two languages, but is the primary strategy in possessive pronouns (Kadenge & Simango, 2014) (20)–(21).

(20). Vowel elision in nouns and possessive pronouns (Kadenge & Simango, 2014, p. 117).

/tʃĭ-a^{ŋ}gu/	[tʃa^{ŋ}gu]	'mine'
/tʃĭ-asu/	[tʃasu]	'ours'
/tʃĭ-ake/	[tʃake]	'hers'
/li-a^{ŋ}gu/	[la^{ŋ}gu]	'mine'
/li-asu/	[lasu]	'ours'
/li-ake/	[lake]	'hers'
/ka-ako/	[kako]	'yours'
/ka-asu/	[kasu]	'ours'
/ka-awo/	[kawo]	'theirs'
/tʃĭ-ola/	[tʃola]	'bag'
/tʃĭ-ulu/	[tʃulu]	'ant hill'
/tu-o^{n}se/	[to^{n}se]	'all'
/ku-o^{n}se/	[ko^{n}se]	'all'

(21). Vowel elision in nouns and possessive pronouns (Kadenge & Simango, 2014, p. 117).

/ri-a^{ŋ}gu/	[ra^{ŋ}gu]	'mine'
/ri-eɗu/	[reɗu]	'ours'
/ʐ̤i-a^{ŋ}gu/	[ʐ̤a^{ŋ}gu]	'mine'
/tʃĭ-ake/	[tʃake]	'mine'
/tʃĭ-oja/	[tʃoja]	'public hair'
/ʐ̤i-uru/	[ʐ̤uru]	'ant hills'
/pa-ake/	[pake]	'his'
/ka-aʋo/	[kaʋo]	'theirs'
/mu-ojo/	[mojo]	'heart'
/mu-o^{ŋ}go/	[mo^{ŋ}go]	'bone marrow'

Vowel elision also occurs in the verbal domain in both ciNsenga and ChiShona (Kadenge & Simango, 2014) (22)–(23).

(22). Vowel elision in verbs in ciNsenga (Kadenge & Simango, 2014, p. 117).

/si-u-ka-ni-ti^{m}b-a/	[sukaniti^{m}ba]	‘you (sg) will not beat me’
/ni-a-fum-a/	[nafuma]	‘I came out’ (hodiernal)
/ti-e-lal-a/	[telala]	‘we slept’

(23). Vowel elision in verbs in ChiShona (Kadenge & Simango, 2014, p. 117).

/ti-a-dʒ-a/	[tadʒga]	‘we ate’
/^{n}di-a-karar-a/	[^{n}dakarara]	‘I slept’
/ʋa-a-dʒg-a/	[ʋadʒg-a]	‘they ate’

In the study of Xitsonga (Vratsanos & Kadenge, 2017), vowel elision also occurs in noun class prefixation, and the elision of V_1 is also more common than of V_2.

Previous studies show the existence of vowel elision in Bantu languages, but this type of hiatus resolution is not found in Isbukun Bunun, Squliq Atayal, and Paiwan. Although the repairing process in these languages seems like a straightforward vowel elision, both Huang (2006) and Yeh (2011) claim the process as coalescence. The next subsection gives further explanations on this transformation.

2.2.4 Coalescence

Coalescence is another type of hiatus resolution, and literally indicates two non-identical/ identical vowels merging to form a new vowel that has the same features as the original vowels. Coalescence also takes place when hiatus is composed of two identical vowels in Isbukun Bunun (Hunag, 2006) (24).

(24). Coalescence in Isbukun Bunun verbs (Huang, 2006, p. 5)

a. /tutu-un/	[tutún]	‘pour out’
b. /taʔaða-a/	[taʔaðá]	‘listen to’

In (24) the hiatus resolution is shown of two juxtaposed vowels in the input. The surface is a single vowel with stress. This phenomenon is a straightforward vowel elision, but Huang (2006) defines it as coalescence because the stress is assigned. The author further explains that, in general, languages obey the Weight-to-Stress Principle (WSP), so the final syllable of the surface form associates with two underlying vowels. Placing stress on the penult causes a violation of WSP. Moreover, both moras of the two identical vowels in the input must be retained, so coalescence can better explain this type of resolution since the quantity of input vowels is not affected. Coalescence of two identical vowels is also found in Squliq Atayal (25).

(25). Coalescence in Squliq Atayal verbs (Huang 2006, p. 12).

a. /tbuci-i/	[tbuci]	'to separate'
b. /pnbu-un/	[pnbun]	'to cause to be sick'
c. /kita-an/	[kitan]	'to see'

The adjacent identical vowels in (25) are similar to the data of Isbukun Bunun. As discussed earlier, Isbukun Bunun obeys WSP, so the surface of the two underlying juxtaposed vowels must retain the moras of the input. The same rule does not apply in Squliq Atayal, however, and the examples in (25) also show a simple vowel elision, but Huang (2006) explains that coalescence can better describe this type of hiatus resolution. The reduction rule in Squliq Atayal affects all vowels except the last two vocalic elements, which avoid being reduced because they are grouped into a foot. The reduction generalization thus remains transparent in a coalescence account of the data (25) but would be opaque in a deletion analysis (Huang, 2006, pp. 12–13). This explanation is shown in (26).

(26). a. A deletion account:

	/kita$_1$-a$_2$n/			/kita$_1$-a$_2$n/
Reduction	kəta$_1$-a$_2$n		Deletion	kita$_2$n
Deletion	kəta$_2$n		Reduction	kita$_2$n
	[kəta$_2$n]			*[kita$_2$n]

b. A coalescence account:

	/kita$_1$-a$_2$n/	or		/kita$_1$-a$_2$n/
Reduction	kəta$_1$-a$_2$n		Coalescence	kita$_{1,2}$n
Coalescence	kəta$_{1,2}$n		Reduction	kəta$_{1,2}$n
	[kəta$_{1,2}$n]			[kəta$_{1,2}$n]

(Huang, 2006, p. 13)

Yeh (2011) also proposes coalescence in Paiwan, in which two identical vowels is repaired by coalescence to form a single segment (27).

(27). Coalescence in Paiwan (Yeh, 2011, p. 76).

/pu-vasa-an/	[sán]	‘taro fields’
/pu-ada-an/	[dán]	‘onion fields’
/ka-kəsa-an/	[sán]	‘kitchen’
/kaḻi-i/	[ḻí]	‘dig (imp.)’
/vəḻi-i/	[ḻí]	‘buy (imp.)’
/kat͡su-u/	[t͡s^{h}ú]	‘carry (imp.)’
/kiʀimu-u/	[mú]	‘come (imp.)’

Example (27) shows coalescence as the repair strategy of two identical vowels. According to Yeh, this type of hiatus resolution is based on its interaction with stress, which is the same as in Isbukun Bunun (Huang, 2006). The previous studies of three Formosan Austronesian languages identify coalescence of two identical vowels as one of their hiatus repair strategies. In Nguni languages, coalescence is also one of the strategies to resolve two identical vowel sequences (28) (Sibanda, 2009). Coalescence also takes place when the vowel a is followed by a, i or u (29).

(28). Combination of Identical Vowels (excluding a+a) (Sibanda, 2009, p. 39).

a. i+i=i

b. e+e=e

c. o+o=o?

d. u+u=u?

Sibanda explains that the combination of o+o and u+u is not found in any of the Nguni languages, but one can guess the outcome might be a monomoraic o and u respectively from the combination of identical vowels of (28a) and (28b). Sibanda also presents other coalescence combinations, as shown in (29).

(29). Coalescence when the first Vowel is /a/ (Sibanda, 2009, p. 39)

a. a+a=a

b. a+i+e

c. a+u=o

Casali (2011) explains this as a type of height coalescence in which a non-high vowel is yielded in the environment of a non-high V_1 and a high V_2. The combination in (29) can be explained using the data in isiXhosa, where the two vowels coalesce and form a short single vowel segment rather than a long or double vowel (30).

(30). Coalescence in isiXhosa (Aoki, 1974, p.234)

a. a + a > a	/wa +aɓa+ntu/	[waɓantu]	'for the people'
	/aɓa + akhi/	[aɓakhi]	'builders'
b. a + i > e	/wa + inkosi/	[wenkosi]	'of the chiefs'
	/na + impendulo/	[nempendulo]	'with the answer'
c. a + u > o	/wa + umfazi/	[womfazi]	'of the woman'
	/na +um +ntu/	[nomntu]	'with the person

Coalescence in Shona is also another example of height coalescence. The same pattern of coalescence shown in (29) is also present in the study of Shona by Harford (1997) and Mudzingwa (2013) (31).

(31). Coalescence combinations in Shona (Harford, 1997 p. 70)

a. a+a=a

b. a+i=e

c. a+u=o

Harford (1997) and Mudzingwa (2013) identify coalescence as a common phenomenon in Bantu languages, and it occurs in the cliticisation domain in Shona. In other words, coalescence takes place across an encliticisation or procliticisation boundary. Shona noun class prefixes contain three vowels: [a], [i], and [u], which produce the frequent combinations in (32).

(32). Coalescence in cliticisation domain in Shona (Mudzingwa, 2013, p. 7).

/ná=ù-j-ù/	[nójù]	'with this one'
ASSOC=STAB-CL1.DEM.AFX		
/ná=ì-dᶻó/	[nèdᶻó]	'with it'
ASSOC=STAB-CL10.PRON.AFX		
/ná=à-ʋò/	[náʋò]	'with these ones'
ASSOC=STAB-CL2.DEMON.AFX		

It is known from the above-mentioned studies that coalescence is decided based on the phonological rules in three Formosan Austronesian languages and isiXhosa, while in Shona coalescence depends on the morpho-syntactic concatenation. The comparative analysis of the present study will focus on the phonological type of coalescence which both Bantu and Formosan Austronesian languages have in common.

The phonological rules of languages are applied to decide which vowel is deleted and which is retained. The resolution of epenthesis is restricted to certain consonants, glide formation is blocked in certain vowel configurations, and coalescence is determined by the height of the vowel sequence. An analysis of Ogori, Emai, Okpe, and Chichewa by Casali (1997) shows how V_1 and V_2 are resolved under certain linguistic restrictions, while Rosenthall (1997) focuses on the prevocalic (V_1) distribution by using the phonological data of Luganda, Etsako, Yoruba, and Kimatuumbi. Hiatus resolution seems to be an important aspect in categorizing languages and distinguishing them from one another.

These previous studies utilized OT to explain different linguistic rules of languages, or the differences among languages/dialects. OT has been utilized in many studies that focus on hiatus resolution in Bantu languages, such as ciNsenga and ChiShona (Kadenge & Simango, 2014), Xitsonga (Vratsanos & Kadenge, 2017), siSwati (Harford & Malambe, 2015), and Nguni languages (Sibanda, 2009). Studies that focus on OT constraints on different linguistic aspects have shown the disfavored hiatus phenomenon in most of the Bantu languages. The articles of Huang (2005, 2006, 2014) and Yeh (2011) also indicate that Isbukun Bunun, Squliq Atayal, and Paiwan of the Formosan Austronesian language family, also do not tolerate hiatus. These researchers use OT approaches to study linguistic differences between languages from the same language family or dialects of the same language. In most cases, dialects of the same language or languages from the same language family share the same set of constraints. However, different rankings of the same set of constraints are the key elements that distinguish one language from another. Park (1997) shows these comparisons of constraint rankings and their representing languages in his study of minimality.

A comparative study of hiatus resolution on Formosan Austronesian and Bantu languages is not currently available. It is hoped that the similarities and differences between hiatus resolutions in the selected Formosan Austronesian and Bantu languages will be discovered through precisely such a comparative analysis. In addition, the aim of the empirical analysis and cross-examination of OT constraints is to test the possibility of applying different constraints to other languages. The present study strives to reveal the resemblances between the two language families and hopes to lead to an extensive study on related topics in the future.

2.3 Conclusion

This chapter consisted of the review and discussion of some empirical and theoretical studies on each hiatus resolution. The review and discussion provided an insightful framework for the present investigation, namely the possibility of a comparative analysis of hiatus resolution across Bantu and Formosan Austronesian language families, since the selected studies all focused on and conducted analysis within the same language family. The aim is to fill the gap by comparing the OT constraints of selected languages from these two language families and to provide useful findings that can form the basis for future studies on relevant topics across Bantu and Formosan Austronesian language families. The next chapter encompasses research methodology, explaining how data were collected and analyzed in the study.

Chapter 3: Research methods

3.1 Introduction

Chapter 3 encompassed a review and explanation of consolidated descriptive and formal comparative analyses of repair strategies used to resolve vowel hiatus in Bantu and Formosan Austronesian languages. It also presented a concise introduction of the framework of Optimality Theory. This chapter provides a brief description of the methods employed in collecting and analyzing data. As mentioned earlier, Optimality Theory is used to analyze data in this study.

3.2 Source of Data

Four Bantu and two Formosan Austronesian languages were selected for this comparative study. Repair strategies used to resolve vowel sequences have been demonstrated in previous studies by Rosenthall (1997), Huang (2006), Casali (2011), and Kadenge and Simango (2014), among many others. These articles present adequate linguistic data on the selected languages, including the background, geographical information, and morphosyntactic aspects, which support the hiatus resolution analysis. In addition, findings from these articles provide comprehensive and thorough comparative results and constraint rankings of the selected languages. The results and linguistic data, especially the corpus, from these articles were thus used for the present study.

3.2.1 Data on Bantu Languages: Luganda, ciNsenga, ChiShona, and isiXhosa.

The data on Luganda are taken from Rosenthall (1997), who introduces both glide formation and vowel elision of the language. Kadenge and Simango (2014) provide data on both ciNsenga and ChiShona, and they present a formal comparative analysis of hiatus resolution in the two languages. Abundant information and discussion on different repair strategies are presented in the article, but the present study merely focuses on glide formation of ciNsenga and ChiShona in order to carry out the present comparative analysis. In addition, some data on ChiShona coalescence were obtained from Harford (1997). As mentioned in the previous chapter, Casali (2011) mainly focuses on different strategies of hiatus resolution. Casali's research provides a plentiful corpus of phonological rules of isiXhosa, and the author also explains the transformation of identical vowel elision in Luganda. These findings all make up valuable data for the present study.

3.2.2 Data on Formosan Austronesian Languages: Isbukun Bunun and Squliq Atayal

Huang (2006) has examined the strategies used to handle vowel clusters in both Isbukun Bunun and Squliq Atayal. Both glide formation and coalescence in Isbukun Bunun and Squliq Atayal are comprehensively interpreted. Huang collected these language data by doing fieldwork herself because the surface form of these two Formosan languages can only be found in verbal communication, not in written form. Moreover, the existing online dictionary[5] of Bunun and Atayal lacks explanations and IPA for these phonological changes of vowel sequences. For this reason, fieldwork is crucial in discovering hiatus resolution in the Formosan Austronesian languages. Other studies that focus on glide formation in Isbukun Bunun (Huang, 2005) and Squliq Atayal (Huang, 2014) were also consulted as auxiliaries for the researcher to obtain a better understanding of the distribution of hiatus in these two languages.

3.3 Data Analysis Method

A comparative analysis of hiatus resolution of two Formosan Austronesian and four Bantu languages is the main focus of this study. Constraints of these languages were analyzed, compared, and cross-examined. The subjects of the comparative analysis are glide formation, coalescence, and vowel elision as the selected languages from two language families share the same strategies. In other words, for the same type of resolution, constraint rankings of the selected Bantu languages are applied to the Formosan Austronesian languages to examine whether the constraints are applicable and whether they yield the optimal candidate.

[5] 原住民族語言線上詞典 - 原住民族委員會 [Indigenous Languages on-line Dictionary – Council of Indigenous Peoples] (Council of Indigenous Peoples, n.d.)

Furthermore, constraints of Squliq Atayal are also adopted to test their applicability to coalescence in isiXhosa.

3.3.1 Optimality Theory (OT)

The analysis follows OT as the main theoretical framework. From 1993 onwards, OT (J. McCarthy & Prince, 1993) has been adopted in the field of phonology (33). OT proposes that Universal Grammar contains a set of violable constraints. The constraints spell out universal properties of languages. OT also proposes that each language has its own ranking for these constraints.

(33). The principles of OT are as follows (McCarthy & Prince, 1993, pp. 1–2):

(i) Violability

Constraints are violable, but violation is minimal.

(ii) Ranking

Constraints are ranked on a language-particular basis; the notion of minimal violation is defined in terms of this ranking.

(iii) Inclusiveness

The constraint hierarchy evaluates a set of candidate analyses that are admitted by very general considerations of structural well-formedness. There are no specific rules or repair strategies.

(iv) Parallelism

Best-satisfaction of the constraint hierarchy is computed over the whole hierarchy and the whole candidate set. There is no serial derivation.

Differences between constraint rankings result in different patterns, giving rise to systematic variation between languages (Archangeli & Langedoen, 1997, p.11). Simply put, in the process of analyzing a language, GEN (for Generator) creates a set of candidates from a given input for possible outputs; EVAL (for Evaluator) examines the candidates by obeying the constraint hierarchy of that particular language, and selects the optimal candidate.

The characteristics of the OT constraints are universality, violability, optimality, and domination (Kadenge & Simango, 2014). Universality means constraints are universal, so even though languages in the world are different, some of them are share the same set of constraints with different rankings. Constraints are violable, meaning any potential candidates violate one or more of the constraints, so the candidate that has the least violation is the optimal candidate. In addition, the optimal candidate cannot violate any of the higher-ranking constraints; this is what optimality in OT refers to. Higher-ranking constraints dominate those with lower rankings, and these two parts of constraints are in conflict with one another.

Kager (1999) indicates two broad categories of constraints in OT, namely, markedness constraints and faithfulness constraints. Most of the selected languages in the present study have potential onsetless syllables, and markedness triggers hiatus resolutions. The role of markedness constraints is to rule out any candidates that have violations in the surface form. Faithfulness constraints then require correspondence of input and output. The OT constrains are ranked and language dependent, meaning every language has its own constraint hierarchy based on its phonological environment. In addition, some dialects of one language share the same of constraints, but differ in ranking, as certain constraints are higher in the hierarchy than others.

It should be noted that in the analysis of hiatus resolution, OT is the priority for many scholars. Due to the insight, it provides into language variability, this study also adopted OT for a comparative analysis. It is also known that constraints of the same repair strategies cannot be identical due to the differences of certain morphosyntactic rules. Even though the hiatus resolutions of the selected languages from the two language families are highly similar, their constraint hierarchies are slightly different. In the comparative analysis, these constraints were investigated and discussed in detail in order to discover the similarities and differences between the two language families. Furthermore, constraint ranking from one language family is utilized to examine the applicability on the other.

When applying the OT formal model in language analysis, a tableau form is typically used. Below is an example of an OT tableau.

Tableau 1. Example of OT tableau (Khan, 2016, p.55).

Language X: Constraint 1, Constraint 2, Constraint 3 >> Constraint 4

/input/	Constraint 1 Highest ranked	Constraint 2	Constraint 3	Constraint 4 Lowest ranked
a. Candidate 1	*!			
☞b. Candidate 2				*
c. Candidate 3			*!	

In the tableau above, language X refers to a specific language being analyzed, and the formula next to it is the constraints ranking of that language. It shows that constraint 1, 2, and 3 dominate constraint 4, and is symbolized by (>>). This hierarchy is repeated in the tableau where constraint 1 is situated to the left of the tableau, meaning this specific constraint is highly ranked. In other words, the lowest ranked constraint is located in the right-most column of the tableau. Constraints 1, 2, and 3 are separated by commas in the formula, and the dotted line in the tableau indicates that there is no crucial ranking between them. The symbol of (>>) is represented by a solid line in the tableau. Input and output candidates are placed at the far left of the tableau. An asterisk (*) means a violation, and an exclamation mark (!) refers to a fatal violation of a constraint. The candidate that violates the constraint in the lowest ranking is assigned a pointer (☞), showing that the candidate is optimal. Constraints are represented by abbreviations. For instance:

(34). Max-IO (McCarthy and Prince, 1995) requires every segment of the Input to have a correspondent in the Output. In other words, no phonological deletion is permitted;

(35). Dependency (McCarthy and Prince 1995) requires every segment of the Output to have a correspondent in the Input. This means epenthesis is prohibited.

For a language that disfavors vowel elision as the hiatus resolution, Max-IO is ranked higher in the OT hierarchy. In contrast, a language that deletes one of the vowels as the repair strategy will have Max-IO in a lower ranking.

Subsequently, in an OT analysis, a detailed description of information analyzed in the tableau is presented and spelled out as follows: The tableau above shows that the violation of constraints 1 and 3 is prohibited in language X, therefore candidates 1 and 3 are ruled out. However, candidate 2 satisfies constraint 1, 2, and 3, and violates the lowest ranked constraint. In this case, the violation of constraint 4 is more harmonic, therefore candidate 2 is the optimal candidate.

3.4 Conclusion

This chapter explained the source of data and the research method employed in this study. A corpus and the OT constraints of Luganda, ciNsenga, ChiShona, isiXhosa, Isbukun Bunun, and Squliq Atayal were gathered from existing research articles. The relevant constraints of the two Formosan Austronesian and four Bantu languages can now be verified and compared in terms of each of the hiatus resolution strategies (see Chapter 4). The linguistic data and OT constraints provide reliable and useful information for the comparative study, and the typical OT constraint tableau offered a comprehensive explanation of the OT analysis. The following chapter demonstrates in more detail how the data were gathered and grouped, including the process of narrowing down the collected data to certain repair strategies. The OT constraints of these languages are briefly discussed, and some sociolinguistic and phonological aspects of the selected languages are also presented in the next chapter.

Chapter 4: Research Data and Analysis

4.1 Introduction

The previous chapter provided a detailed explanation of the methodological approaches employed in comparative studies of hiatus resolution of selected Bantu and Formosan Austronesian languages, and of the theoretical framework of OT. The first part of this chapter presents the vocalic and consonantal systems. Hiatus resolution in the selected languages is similar. Therefore, it is important to first investigate their vocalic and consonantal system in order to discover the differences amongst these languages. The second part illustrates hiatus resolutions and OT constraints of the selected languages for a more comprehensive understanding of how other scholars described and applied OT, and the comparative analysis of the OT constraints are also presented in this part.

4.2 Phonological Aspects of the Selected Languages

This section introduces the vocalic/ consonantal inventories, and some phonological aspects of Luganda, ciNsenga, ChiShona, isiXhosa, Isbukun Bunun and Squliq Atayal. The data of ChiShona presents in this study is referring to one of its variety, ChiZezuru. Details of hiatus resolutions and OT constraints are discussed in the comparative analysis section.

4.2.1 Luganda

The vocalic and consonantal inventories of Luganda are presented in Table 3 and 4 respectively.

Table 3. Vocalic Inventory of Luganda (Casali, 1998).

	Front	Back
Close	i/ ii	u/ uu
Close-mid	e/ ee	o/ oo
Open	a/ aa	

Table 4. Consonantal Inventory of Luganda (Soave, 2009).

	Bilabial	Labiodental	Interdental	Alveolar	Alveopalatal	Palatal	Velar
stops	b p			d t		c	g k
flap							
affricate					dʒ		
fricative		v f	z s		ʃ		
trill				r			
flap				ɾ			
nasal	m	ɱ		n		ɲ	ŋ
liquid				l			
glide	w					j	

Vowel lengthening and consonantal germination are two notable features in Luganda phonology. All five vowels have short and long forms, and most of the consonants can be germinated. The syllable structure of Luganda is presented by Hyman and Katamba (1999) (Table 5).

Table 5. Syllable Types in Luganda (Hyman & Katamba, 1999, p.350)[6]

a. Utterance-Internal		b. Utterance-Initial		c. Utterance-Final	
Monomoraic	Bimoraic	Monomoraic	Bimoraic	Monomoraic	Bimoraic
CV	CVV CVC_i	CV V N C_i	CVV CVC_i VC_i	CV	CVV

It can be observed from Table 7 that no VV syllable is allowed in Luganda; CVVV syllables containing more than two moras are also not found. In other words, the structure of a bimoraic syllable may only consist of either a long vowel nuclear (VV) or of a vowel and the first half of a geminate consonant (VCi). The contrast of such syllables is shown below (36).

[6] C=onset consonant; VV=long vowel; C_i=first half of a geminate consonant.

(36). Contrast of Monomoraic and Bimoraic in Luganda. (Hyman & Katamba, 1999, p. 351)

a. $[CV]_\sigma$ vs. $[CVV]_\sigma$	ku-lim-a	[ku.li.ma]	'to cultivate'
	ku-liim-a	[ku.lii.ma]	'to lie in wait for'
b. $[CV]_\sigma$ vs. $[CVC_i]_\sigma$	ku-ket-a	[ku.ke.ta]	'to cut off'
	ku-kett-a	[ku.ket.ta]	'to spy'

Example (36a) represents the contrast of an underlying long vowel, and (36b) the phonological germinate. The examples above also indicate that vowel length is contrastive in Luganda. In Hyman and Katamba's study, the transformation of parsing a surface long monophthong in Luganda is one of the focuses. Hyman and Katamba's (1999) corpus further indicates the resolution of vowel sequences in Luganda (Table 6).

Table 6. Examples of Vowel Lengthening in Luganda (Hyman and Katamba, 1999, p.351).

	Underlying	Surface	Gloss
a	/bâ-agal-a/	[báà.ga.la]	'they want'
b	/ku-se-ebu-a	[ku.see.bwa]	'to be ground'
c	/ku-lî-ir-a/	[ku.líì.ra]	'to eat at'
d	/a-lâb-a a-ba-kâzi/	[a.lá.baa.ba.ká.zi]	's/he sees women'
e	/e-n-te e-mû/	[e.ntee.mû]	'one cow'
f	/o-no o-mu-genyi/	[o.noo.mu.ge.nyi]	'this visitor'

Table 8 shows that in the situation when two identical vowels occur, either within words (a-c) or across words (d-f), it automatically generates a long vowel. In addition, high vowel gliding may also result in compensatory vowel lengthening, and the comparative section will discuss this in more detail.

4.2.2 CiNsenga

Table 9 and 10 below show the vocalic and consonantal inventories of ciNsenga. This language consists of five short oral monophthongs and no less than twenty-seven consonants (Kadenge & Simango, 2014).

Table 7. Vocalic Inventory of ciNsenga (Kadenge & Simango, 2014, p. 80)

	[i]	[e]	[u]	[o]	[a]
[coronal]	✓	✓			
[labial]			✓	✓	
[pharyngeal]					✓
[+high]	✓		✓		

Table 8. Consonantal Inventory of ciNsenga (Kadenge & Simango, 2014, p. 80)

	Bilabial	Labio-dental	Alveolar	Palato-alveolar	Palatal	Velar	Labio-velar	Glottal
Stop	p b p^h		t d t^h			k g k^h		
Affricate				tʃ dʒ $tʃ^h$				
Fricative		f v	s z	ʃ ʒ				h
Nasal	m		n	ɲ		ŋ		
Approximant		ʋ			j		w	
Lateral			l					

Vowel length is not contrastive and predictable in ciNsenga (Kadenge and Simango, 2014). CiNsenga is an agglutinative language like other Bantu languages, so affixation is possible to create an ill-formed vowel sequence as prefixes typically appear in (C)V patterns, whereas suffixes have an invariant VC structure. In the study of vowel hiatus of ciNsenga, Simango and Kadenge (2014) illustrate that CiNsenga does not allow closed syllables and complex onsets. Onsetless syllables (V-syllable) are found word initially. They also occur word medially, but this is restricted to the condition when V_2 is verb stem initial. A syllabic nasal (C-syllable) occurs both word initially and medially. The CV-syllable is another type of syllable, in which prenasalized consonants and secondary articulations constitute single C segments rather than consonants clusters.

4.2.3 ChiZezuru of ChiShona.

The data on ChiShona in this section come from one of its dialects, ChiZezuru. The vowel features of ChiZezuru are identical to ciNsenga, and are repeated here as (Table 9).

Table 9. Vocalic Inventory of ChiZezuru (Kadenge, 2014, p. 58)

	[i]	[e]	[u]	[o]	[a]
[coronal]	✓	✓			
[labial]			✓	✓	
[pharyngeal]					✓
[+high]	✓		✓		

Vowel length is also not contrastive in this language. In other words, ChiZezuru does not have long vowels. What is more, this language also lacks diphthongs. Below, (Table 10-11) show the consonant features of ChiZezuru

Table 10. ChiZezuru Simple Consonants (Kadenge, 2014, p. 60).

	Labial	Alveolar	Palatal	Velar	Glottal
Voiceless plosives	p	t		k	
Breathy voiced plosives	b̤	d̤		g̤	
Implosives	ɓ	ɗ			
Voiced nasals	m	n	ɲ	ŋ	
Breathy voiced nasals	m̤	n̤			
Voiceless 'whistling' fricative	f	s	ʃ		
Breathy voiced fricatives	v̤				
Voiceless 'whistling' fricative		ʂ			
Voiced 'whistling' fricative		ʐ			
Approximant			j		
Trill		r̤			

Table 11. ChiZezuru Complex Consonant Phonemes (Kadenge, 2014, p. 60).

	Labial	Alveolar	Palatal	Velar
Affricates	p^{f} b^{v}	t^{s} d^{z}	tʃ dʒ̤	
Whistling affricate		$t^{ʂ}$ $d^{ʐ}$		
Prenasalized plosives	^{m}b	^{n}d		^{ŋ}g
Prenasalized fricatives	m^{v}	n^{z}		
Labialized prenasalized fricative		nʐ		
Velarized plosives	p^{w} b^{w}	t^{w} d^{w}		
Velarized nasals	m^{w}	n^{w}		
Prenasalized velarized plosives	$^{m}b^{w}$			$^{ŋ}g^{w}$
Prenasalized velarized fricative		$^{n}z^{w}$		
Labiovelar glides				w w̤

It can be noted from (Table 10-11) that ChiZezuru consonants are divided into two categories: simple and complex consonants, and they are contrastive. The complex segments such as affricates, prenasalized consonants and secondary articulations are considered single segments or simple onsets rather than consonant clusters. The study in Kadenge (2014) defines the labialized consonants (C^{w}s) in ChiZezuru as complex segments, that is, the /w/ articulation does not stand alone as a single segment but as a secondary articulation on the preceding consonant.

4.2.4 IsiXhosa

IsiXhosa features 5 vowels (Table 12). Vowel length is predictable, and in most cases, not contrastive, as Xhosa features penultimate lengthening (VanderStouwe, 2009; Zerbian, 2004).

Table 12. IsiXhosa Vowel Inventory (VanderStouwe, 2009, p.3)

Vowels	Front	Central	Back
High	i		u
Mid	e		ɔ
Low		a	

Consonant inventory in isiXhosa is relatively rich, including pulmonic egressive sounds, velaric ingressive sounds (clicks), and one glottis ingressive sounds (implosive). Table 13 below shows the consonant sounds in isiXhosa.

Table 13. IsiXhosa Consonant Inventory (VanderStouwe, 2009, p.8)

a. Pulmonic Sounds and Implosive Sounds:

Consonants	Bilabial		Labio-dent.		Alveolar		Postalv.		Palatal		Velar		Glottal	
Plosive	p p^h	b			t t^h	d			c c^h	ɟ	k k^h	g		
Implosive		ɓ												
Nasal		m				n				ɲ		ŋ		
Trill						r								
Fricative			f	v	s	z	ʃ				x		ɣ	ɦ
Lateral Fricative					ɬ	ɮ								
Affricate					tɬ		tʃ	dʒ						
Approx.	(w)									j	(w)			
Lateral Approx.						l								

b. Velaric Sounds (Clicks):

	1	2	3	4	5	6
Dental	ǀ	ǀ^h	nǀ	ŋ^{g}ǀ	ŋ^{k}ǀ	gǀ
Alveolar	!	!^{h}	ŋ!	ŋ^g!	ŋ^k!	g!
Lateral	ǁ	ǁ^h	ŋǁ	ŋ^{g}ǁ	ŋ^{k}ǁ	gǁ

4.2.5 Isbukun Bunun.

Bunun has four vowels and Isbukun Bunun tends to have three vowels only (Table 14).

Table 14. Takivatan and Isbukun Vowel Inventory (Busser, 2011)

Articulation	Phoneme-Takivatan	Phoneme-Isbukun Bunun
Front Close Unrounded	/i/	/i/
Front Open Unrounded	/a/	/a/
Front Mid Unrounded	/e/	
Back Close Rounded	/u/	/u/

Takivatan, one of the dialects of Bunun, includes four vowels while Isbukun only has three. However, the high vowels /i/ and /u/ have their phonetic variants [e] and [o] respectively when adjacent to /h/, for example, /huspil/ [hospil] 'hair'(Li, 2015, p.125). Surface glide [j] and [w] are derived from underlying vowels /i/ and [u] respectively in order to satisfy the requirement that syllables must have onset consonants (Huang, 2006, p. 4)

The consonantal inventory of Isbukun Bunun contains 14 consonants (Table 15).

Table 15. Isbukun Bunun Consonantal Inventory (Huang, 2006)

	Labial	Coronal	Velar	Glottal
Stop	p b	t d	k	ʔ
Fricative	v	s ð		h
Nasal	m	n	ŋ	
Liquid		l		

Consonants can be found in the word-initial, medial, and final position, but consonant clusters are only allowed word-medially.

4.2.6 Squliq Atayal.

Squliq Atayal has five vowels (Table 16) and nineteen consonants (Table 17).

Table 16. Squliq Atayal vocalic inventory

	Front	Centre	Back
High	i		u
Mid	e		o
Low		a	

Table 17. Squliq Atayal consonantal inventory (Huang, 2006, p. 10)

	Labial	Alveolar	Palatal	Velar	Uvular	Pharyngeal	Glottal
Stop	p	t		k	q		ʔ
Affricate		c					
Fricative	b[β]	s z		x g[ɣ]		h	
Nasal	m	n		ŋ			
Liquid		r l					
Glide			j	w			

Neither Isbukun Bunun nor Squliq Atayal allows complex syllable margins. Isbukun Bunun has syllables of maximally CGVC and CVGC, and minimally CV. However, Squliq Atayal bans CVGC syllables. This limitation results in different ways of resolving hiatus in the two languages.

This first section introduced the vocalic/ consonantal inventories, phonological environment and limitations of some selected languages. Data of these phonological aspects are drawn from existing studies. These phonological rules, vowel sequence repair strategies and OT constraint rankings are discussed in the following section and used for a thorough comparative analysis.

4.3 Data Analysis

This section presents a comparative analysis of hiatus resolutions—glide formation, vowel elision and coalescence—of two Formosan Austronesian languages, Isbukun Bunun and Squliq Atayal, with selected Bantu languages, Luganda, ciNsenga, ChiShona, and isiXhosa. Glide formation is found in all these languages, coalescence is found in all except ciNsenga, and vowel elision is found in all except Isbukun Bunun and Squliq Atayal. However, the surface form of a single vowel of two underlying identical adjacent vowels in two Formosan Austronesian languages is just like a straightforward vowel elision, but it has been categorized as coalescence.

This section is organized as follows: §4.3.1 provides all the data of glide formation in ciNsenga, ChiShona, Luganda, Isbukun Bunun, Squliq Atayal and isiXhosa, and illustrates the phonological rules of glide formation in these languages. OT constraints of these languages are discussed in §4.3.2, and the fusion version of constraint rankings of ciNsenga, ChiShona and Luganda is utilized as a cross-examination of Isbukun Bunun and Squliq Atayal. The final part summarizes the glide formation of the six selected languages and listed out their constraint rankings. Coalescence and vowel elision are discussed in §4.3.3. As mentioned earlier, coalescence in Isbukun Bunun and Squliq Atayal can be interpreted as a vowel elision, so such coalescence resolution is discussed in detail with the example of vowel elision in Luganda. Data from isiXhosa and ChiShona are introduced to highlight the similarities of coalescence performances. This section precedes a comparative table that illustrates the similarities and differences of coalescence within Luganda, isiXhosa, ChiShona, Isbukun Bunun and Squliq Atayal. The last part, §4.3.4, turns the focus back to the OT constraints of coalescence and vowel elision. Due to the similarities of coalescence and vowel elision within Luganda, Isbukun Bunun and Squliq Atayal, constraint rankings of Luganda are used to yield the optimal candidate of the two Formosan Austronesian languages. Due to the limited source data of constraints the author could find for isiXhosa, constraint rankings of ChiShona were operated to examine the applicability of selecting optimal candidates in vowel elision isiXhosa. And more, the same set of constraints proposed in §4.3.2 is used to illustrate other two types of hiatus (coalescence and coalescence + glide formation) in isiXhosa.

4.3.1 Glide formation

Glide formation is one of the most common repair strategies for resolving vocalic hiatus in ciNsenga and ChiShona. It occurs when V_1 is a high vowel, and this high vowel loses its moraicity by being turned into a glide which serves as an onset for V_2. A non-high V_1 is deleted without compensatory lengthening (Kadenge & Simango, 2014, p. 110). In addition, glide formation only occurs when V_1 (/u/ or /i/) is not preceded by a consonant, otherwise, secondary articulation is triggered. Luganda has a similar glide formation phenomenon to ciNsenga and ChiShona, but after V_1 turns into a glide, V_2 becomes a long vowel (Rosenthall, 1997). In the case of Isbukun Bunun and Squliq Atayal, high vowels glide regardless of whether they are in the position of V_1 or V_2 (Huang, 2005, 2006, 2014). This can also be considered high vowel resolution since the glide strategy only targets high vowels. The distribution of high vowels of ciNsenga, ChiShona, Luganda, Isbukun Bunun, and Squliq Atayal are shown in Table 18 to 23.

Table 18. Glide formation in ciNsenga verbs (Kadenge & Simango, 2014, p. 112)

	Underlying	Surface	Gloss
a	/u-a-li.l-a/ 1SM-PST-cry-FV	[walila]	‘he/she cried’ (hodiernal)
b	/i-a-fom-a/ 9SM-PST-sweat-FV	[jafoma]	‘it sweated’ (hodiernal)
c	/u-e-^{n}zemu-tui/ 3SM-PST-be CL3-head	[we^{n}zemutu]	‘it was a head’
d	/i-e-$_n$zemi-tu/ 4SM-PST-be CL4-head	[je^{n}zemitu]	‘they were heads’

Table 18 shows that V_1 [i] turns into the palatal glide [j] and [u] the labio-velar glide [w], so the high vowel and the resultant share the same feature content.

Table 19. Glide formation in ChiShona verbs (Kadenge & Simango, 2014, p. 112)

	Underlying	Surface	Gloss
a	/u-a-dʒg-a/ 3SM-PST-eat-FV	[wadʒga]	'you are'
b	/u-a-e^{n}d-a/ 3SM-PST-go-FV	[waje^{n}da]	'you went'
c	/i-a-dʒg-a/ 9SM-PST-eat-FV	[wadʒga]	'it ate'
d	/i-a-e^{n}d-a/ pSM-PST-go-FV	[jaje^{n}da]	'it went'

ChiShona high vowel glide formation is identical to ciNsenga, that [j] and [w] are derived from V_1, [i] and [u]. The hiatus resolution of high V_1 and non-high V_2 is summarized in (37).

(37). Gliding of high vowels (Kadenge & Simango, 2014, p. 113)

a. /u+a/ [wa]
b. /u+e/ [we]
c. /u+o/ [wo]
d. /i+a/ [ja]
e. /i+e/ [je]
f. /i+o/ [jo]

Table 20. High vowel gliding in Luganda (Hyman & Katamba, 1999, p. 351)

	Underlying	Surface	Gloss
a	/ku-kîal-a/	[ku.kyáà.la]	'to visit'
b	/ku-tûal-a/	[ku.twáà.la]	'to take'
c	/ku-lî-a/	[ku.lyáà…]	'to eat'
d	/ku-gu-a/	[ku.gwaa…]	'to fall'
e	/mu-limi + o-mû/	[mu.li.myoo.mû]	'one farmer'
f	/n-fûdu + e-mû/	[n.fú.dwèè.mû]	'one tortoise'

Table 20 expresses similar glide formation to ciNsenga and ChiShona that high vowel glides. However, in Luganda, glide formation results the lengthening of V_2. Table 21 below shows another example of glide formation in Luganda. Rosenthall (1997, p.150) explains the prevocalic distribution of Luganda in his article: the high prevocalic vowels glide, the non-high vowels are deleted, and the surface vowel becomes a long monophthong. For example, /li+ato/ becomes [l^{y}a:to] and /ka+oto/ becomes [ko:to].

Table 21. Glide formation in Luganda nouns (Rosenthall, 1997, p. 150)

	Underlying	Surface	Gloss
a	/li+ato/	[l^{y}a:to]	'boat'
b	/ki+uma/	[k^{y}u:ma]	'metal object'
c	/mu+iko/	[m^{w}i:ko]	'trowel'
d	/mu+oyo]	[m^{w}o:yo]	'soul'

Therefore, gliding in Luganda also targets high vowels, and hiatus resolution, including vowel elision, will result in vowel lengthening of V_2.

Table 22. Glide formation in Isbukun Bunun verbs (Huang, 2006, p. 5)

	Underlying	Surface	Gloss
a	/sadu-av/	[sadwáv]	'see'
b	/silulu-av/	[šilulwáv]	'pull'
c	/silili-av/	[šililjáv]	'imitate'
d	/pavali-av/	[pavaljáv]	'shine upon'
e	/tupa-un/	[tupáwn]	'tell'
f	/pasnava-un/	[pasnaváwn]	'learn'
g	/taʔáða-un/	[taʔáðawn]	'listen to'

Table 22 illustrates that surface glide [j] and [w] are also derived from the underlying vowel [i] and [u] respectively. Unlike ciNsenga, ChiShona, and Luganda where only high vowels in V_1 position glide, Isbukun Bunun's high vowels glide in either V_1 or V_2 position. Examples from Table 18 also shows glide formation result stress assignment of the remaining vowel (V_1 or V_2), which is similar to Luganda's compensatory lengthening of V_2. Candidates (Table 22e) and (Table 22f) in the table above show that gliding occurs in V_2 while V_1 is a non-high vowel. In addition, Isbukun Bunun only has three vowels, [i], [u], and [a], so there is no other hiatus combination such as /u+e/ or /i+o/, in contrast with (29). Nevertheless, the table above proves that only the high vowels are responsible for gliding.

Table 23. Glide formation in Squliq Atayal verbs (Huang, 2006, p. 12)

	Underlying	Surface	Gloss
a	/soja-i/	[sjaj]	'to like'
b	/mʔabi-a/	[mʔbja]	'to sleep'
c	/mnbu-a/	[mnbwa]	'to be sick'
d	/tutu-i/	[ttuj]	'to tell trees'
e	/hkani-an/	[hknjan]	'to walk'
f	/biru-an/	[brwan]	'to write'
g	/tbuci-un/	[tbcjun]	'to separate'

It is also clear from the Squliq Atayal data that only high vowels glide, just like in the four other languages mentioned above. According to Huang (2006), glide formation occurs under two circumstances: first, when a –V suffix and the final vowel of the preceding stem are non-identical and second, when the final vowel of the stem and the vowel of a –VC suffix do not fall in sonority. What is more interesting is that Squliq Atayal has vowel sequences of two high vowels while the other languages distribute a combination of a high vowel with a non-high. In Table 25, (d) and (g) are examples where two high vowels coexist. V_2 undergoes glide formation in (d), and V_1 in (g). Huang (2006) explains that the maximal syllable in Squliq Atayal is CGVC but not CVGC. Therefore, the surface form of *[tbciwn] in (g) is disallowed since it creates a CVGC syllable. The explanation cannot be satisfied fully with (d). In the case above, the possible explanation to resolve all the examples can be:

(i) glide formation is restricted to falling sonority;
(ii) only high vowels undergo glide formation; and
(iii) when two high vowels coexist, front high vowel [i] glides.

Unlike the above-mentioned languages that glide formation targets high V_1, in isiXhosa, only round V_1 undergoes glide formation before a following non-round vowel (Casali, 2011, p.18). (38) below shows gliding in isiXhosa.

(38). Gliding in isiXhosa.

a. o+e=we

b. o+a=wa

c. u+i=wi

d. u+e=we

e. u+a=wa

4.3.2 Optimality Theory constraints of glide formation

Both ciNsenga and ChiShona require every syllable to have onsets, so ONSET (39) is ranked higher. *V: (40) follows ONSET as a higher constraint because vowel length is not contrastive in ciNsenga and ChiShona, and, as a result, gliding of V_1 does not result in lengthening of V_2, although the hiatus resolution causes a loss of moras. In contrast, MAX-IO(μ) (41) is in lower constraint. In addition, glide formation takes place prior to vowel elision, so that MAX-IO (RT) (42) dominates MAX-IO(μ). MAX-IO (RT) requires every root node in the input to have a correspondent in the output, and this constraint will rule out deletion of either V_1 or V_2 that attempts to satisfy ONSET. The constraint ranking of ciNsenga and ChiShona gliding in Table 20 shows how it ruled out the ungrammatical candidate.

(39). ONSET: syllables must have onsets.

(Itô, 1989, p.223)

(40). *V:: No long vowels.

(Rosenthall, 1997, p.147)

(41). MAX-IO(μ): Every mora of the Input has a correspondent in the Output.

(Rosenthall, 1997, p.164)

(42). MAX-IO (Rt): Every root node in the Input has a correspondent in the Output.

(Mudzingwa, 2010)

Tableau 2. Glide Formation in ciNsenga and ChiShona (Kadenge & Simango, 2014, p. 114).
ONSET, *V: >> MAX-IO (RT) >> MAX-IO(μ)

/u₁.a₂ko/	ONSET	*V:	MAX-IO (RT)	MAX-IO(μ)
a. [u₁.a₂.ko]	*!			
b. [wa₂:.ko]		*!		
c. [a₂.ko]			*!	*
d. [u₁.ko]			*!	*
☞ e. [wa₂.ko]				*

In tableau 2 above, candidate (a) violates the highest constraint, ONSET, by preserving V_1, which is not preceded by any consonants. Candidates (b)–(e) satisfy ONSET, but (b) violates *V: as it lengthened V_2; (c) and (d) delete V_1 and V_2 respectively, which violates MAX-IO (R_T). Therefore, (e) is the optimal candidate.

CiNsenga has glide formation, secondary articulation and elision, while ChiShona has glide formation, secondary articulation, elision, vowel coalescence, and glide epenthesis to resolve vowel hiatus (Kadenge and Simango, 2014). In both languages, the prior vowel repairing strategies is glide formation, so other strategies take place when the prior one is blocked. For example, in ciNsenga, secondary articulation is triggered when glide formation fails, and when both of them are blocked, vowel elision takes place. In addition to the constraints of glide formation in ciNsenga and ChiShona from (39)-(42), Kadenge (2014) introduces another set of ranking (Tableau 3) in a comparative study of chiNambya and ChiZezuru. In this constraint ranking, NO-HIATUS (43) is highly ranked. *V: is also undominated, while MAX-IO(μ) is dominated. Besides, both UNIFORMITY-IO (44) and DEPENDENCY-IO (45) are also undominated since coalescence and epenthesis are not the resolving strategies when V_1 is /u/ or /i/.

(43). NO-HIATUS (*..V)$_{\sigma\ \sigma}$[V..]: A sequence of vowels across a syllable boundary is prohibited.
(Orie and Pulleybalnk, 2002, p.110)

(44). UNIFORMITY-IO: No element of the Output has multiple correspondents in the Input (no coalescence).
(Kager, 1999, p.63)

(45). DEPENDENCY-IO: Output segments must have Input correspondents (no epenthesis).

(Kager, 1999, p.68)

Tableau 3. Glide formation in chiNambya and ChiZezuru (Kadenge, 2014, p. 64).

NO-HIATUS, *V:, UNIFORM-IO, DEP-IO >> MAX-IO (M)

/i₁-a₂ᵑgu/	NO-HIATUS	*V:	UNIFORM-IO	DEP-IO	MAX-IO (M)
a. [i₁.a₂.ᵑgu]	*!				
☞b. [ja₂.ᵑgu]					*
c. [ja:₂.ᵑgu]		*!			
d. [e₃.ᵑgu]			*!		
e. [i.ja₂.ᵑgu]				*!	

Hiatus is not tolerated in either chiNambya or ChiZezuru. Therefore, candidate (a) violates the highest constraint. In addition, it also violates ONSET, one of the higher constraints from tableau 2. Candidates (b)–(e) satisfy NO-HIATUS. However, (d) violates *V: since glide formation does not result in compensatory lengthening of V_2. Candidates (d) and (e) violate UNIFORM-IO and DEP-IO respectively as coalescence and epenthesis are not the hiatus resolution strategies when V_1 is high. Identical to the case of (a), both (d) and (e) also violate ONSET. Candidate (b) turned V_1 into a glide and violates MAX-IO (M), which requires no loss of moras. Such constraint is lower in the ranking, making (b) the winning candidate.

The constraint rankings of glide formation from tableau 2 and 3 explain how the optimal candidate is generated in ciNsenga, chiNambya and ChiZezuru (ChiShona). To conclude the constraints rankings of glide formation in these languages, NO-HIATUS, *V:, ONSET, UNIFORM-IO, and DEP-IO are markedness constraints preceding the faithfulness constraints MAX-IO (RT) and MAX-IO(μ) (46).

(46). NO-HIATUS, *V:, ONSET, UNIFORM-IO, DEP-IO >> MAX-IO (RT) >> MAX-IO(μ)

Hiatus resolution in Luganda focuses on V_1: high V_1 glides, and low V_1 deletes. Moreover, gliding triggers vowel lengthening of V_2. Compared to the constraint ranking from both Tableau 2 and 3, *V: is not ranked high in Luganda. Also, MAX-IO(μ) is ranked higher to ensure every mora in the output corresponds to the input. In addition to these two constraints, Rosenthall (1997) introduced DEP (47), NODIPH (48), SECARTIC (49) and NLV[7] (50) in his paper. DEP is ranked higher as it requires every segment of the output to have a correspondent in the input, so consonant epenthesis is not permitted. The NODIPH constraint indicates no diphthongs in a language, and this constraint is highly ranked in Luganda as well. Gliding of V_1 in Luganda is surfaced as a secondary articulation, and SECARTIC is ranked lower. The constraint ranking of glide formation in Luganda is illustrated in Tableau 4.

(47). DEP: An output must have a correspondent in the input.

(McCarthy & Prince, 1995)

(48). NODIPH: No diphthongs.

(Rosenthall, 1997, p.142)

(49). SECARTIC: Secondary Articulation.

(Rosenthall, 1997, p.147)

(50). NLA: No long vowels.

(Rosenthall, 1997, p.141)

Tableau 4. Glide formation in Luganda (Rosenthall, 1997, p. 154).

DEP, ONSET, NODIPH, MAX-IO(μ) >> SECARTIC, NLV

/li+ato/	DEP	ONSET	NODIPH	MAX-IO(μ)	SECARTIC	NLV
a. [li.a.to]		*!				
b. [lia.to]			*!			
☞ c. [l^{y}a:.to]					*	*
d. [li.ʔa.to]	*!					
e. [l^{y}a.to]				*!		

It is clear from the discussion above that *V: and MAX-IO(μ) are both ranked lower in ciNsenga and ChiShona, but ranked high in Luganda, so the reverse form of constraint rankings like *V: and MAX-IO(μ) results in distinct candidates. Table 8 clearly shows that (a) violates the markedness constraint ONSET. VV syllables are not found in Luganda, therefore (b), which

[7] NLV and *V: are identical.

violates NoDiph, is also ranked out. Epenthesis is not the repair strategy in Luganda, so when /ʔ/ is inserted in (d), it violates Dep. Candidate (e) is also fatal as it causes the loss of a mora. Candidate (c) is the winning candidate since the violation of SecArtic and NLV is more harmonic in Luganda.

Huang (2006) explains in her study that both glide formation and coalescence are hiatus resolution in Isbukun Bunun. The language also requires every syllable to have onset consonants. Therefore, Onset is also ranked higher in the constraint ranking. Identical to all the Bantu languages discussed above, epenthesis is not the most favored hiatus resolution when dealing with high vowels, therefore Dep-IO-C (51) acts as a higher-ranking constraint. It plays a similar role to Dep in Luganda, as inserting a consonant within the conjunction of vowels is not permitted. In addition to the higher constraints, Max-IO-V (52) is also included. The constraint requires an input vowel to have a correspondent in the output, so either V_1 or V_2 is elided. This is similar to Max-IO (Rt) in ciNsenga and ChiShona that ruled out candidates undergoing vowel elision. Coalescence is one of the hiatus resolutions in Isbukun Bunun, therefore Uniformity-IO is required in order to satisfy the coalescence resolution. However, such constraint is undominated in ciNsenga and ChiShona. For deriving the optimal candidate, V-Nuc (53) is ranked lower, so the glided vowels [j] and [w] do not need to occupy the nucleus position of their own syllable. The constraint ranking of Isbukun Bunun is shown in Tableau 5.

(51). Dep-IO-C: An Output consonant must have a correspondent in the Input.

(McCarthy & Prince, 1995)

(52). Max-IO-V: An Input vowel must have a correspondent in the Output.

(McCarthy & Prince, 1995)

(53). V-Nucleus (V-Nuc): Every [-consonantal] segment must be linked to the nucleus without sharing it with other elements.

(Rubach, 2000, p.274)

Tableau 5. Glide formation in Isbukun Bunun (Huang, 2006, p. 9).

ONSET, OCP-PLACE, DEP-IO-C, MAX-IO-V >> UNIFORMITY-IO >> V-NUC

/tup.a$_1$-u$_2$n/	ONSET	OCP-PLACE	DEP-IO-C	MAX-IO-V	UNIFORMITY-IO	V-NUC
a. [tu.pa.un]	*!					
☞ b. [tu.pawn]						*
c. [tu.po$_{1,2}$n]					*!	
d. [tu.pu$_2$n]				*!		
e. [tu.pa.ʔun]			*!			

In Tableau 5, (a) violates the highly ranked ONSET constraint. Candidates (b)–(e) satisfied ONSET by forming a gliding (b), merging a vowel sequence (c), deleting one of the vowels (d), and intervening a consonant (e). Both DEP-IO-C, MAX-IO-V are also highly ranked to ensure no consonant insertion and vowel elision respectively, so these constraints rule out candidates (d) and (e). Candidate (c) violates the coalescence constraint that is ranked lower, but this violation is higher than V-NUC, therefore candidate (b) is optimal.

It is known up to this point that three Bantu languages and Isbukun Bunun share some constraints since they all have glide formation as their primary hiatus repairing strategy. Constraints from Tableau 2, 3 and 4 are drawn and rearranged in Tableau 6 below to test if these constraints are able to surface the grammatically optimal candidate. Example (a) from Table 24 is taken as the experimental subject.

Tableau 6. Gliding in Isbukun Bunun.

NO-HIATUS, DEP, ONSET, NODIPH, MAX-IO (RT) >> UNIFORM-IO >> MAX-IO(μ), /sadu+av/

Candidate	NO-HIATUS	DEP	ONSET	NODIPH	MAX-IO (RT)	UNIFORM-IO	MAX-IO(μ)
a. [sa.du.av]	*!		*!				
b. [sa.du.ʔav]		*!					
c. [sa.duav]				*!			
d. [sa.dav]					*!		*
e. [sa.duv]					*!		*
f. [sa.dov]						*	*
☞ g. [sa.dwav]							*

Candidate (a) retains all the vowels in the input, but violates NO-HIATUS and ONSET. Candidate (a) satisfies ONSET by inserting a consonant as the onset of V_2, but violates DEP. Candidate (c) satisfies ONSET, but violates NODIPH, which is also ranked higher. Candidates (d) and (e) delete V_1 and V_2 respectively. These two candidates satisfy ONSET and NODIPH, but violate MAX-IO (RT) and MAX-IO(μ). Candidate (f) coalesces /u/ and /a/ to form an /o/. Although coalescence is one of the hiatus resolutions in Isbukun Bunun, this constraint is less harmonic than MAX-IO(μ). The last candidate, (g), only violates MAX-IO(μ), which is in the lower ranking of constraints. Therefore, (g) is the optimal candidate.

For the constraints of Squliq Atayal, Huang (2006) introduced a constraint OK-σ (54). As mentioned earlier, CVGC is disallowed in Squliq Atayal. This constraint will prohibit V_2 from undergoing glide formation when both vowels are high (Tableau 8).

(54). OK-σ: Syllable structure obeys the native grammar.

(Yip, 1993)

Tableau 7. Gliding in Squliq Atayal (Huang, 2006, p. 15)

OK-σ, ONSET, OCP-PLACE, DEP-IO-C, MAX-IO-V >> UNIFORMITY-IO >> V-NUC

/hkani-an/	OK-σ	ONSET	OCP-PLACE	DEP-IO-C	MAX-IO-V	UNIFORMITY-IO	V-NUC
a. [hə.Kə.ni.an]		*!					
☞b. [hə.kə.njan]							*
c. [hə.kə.nen]						*!	
d. [hə.kə.nan]					*!		
e. [hə.kə.ni.ʔan]				*!			

Neither consonant epenthesis nor vowel elision is the hiatus resolution, so candidates (d) and (e) are fatal. Candidate (a) violates ONSET, which is the highest constraint because onsetless syllables are also not permitted in Squliq Atayal. Candidate (c) coalesces /i/ and /a/, and violates the second last constraint in the ranking, the constraint that dominates V-NUC. Candidate (b) only violates the constraint in the lowest position, so makes it the winning candidate. However, OK-σ and OCP-PLACE do not interfere with any candidates' glide formation due to the input, and CGVC is tolerated in Squliq Atayal.

The same set of constraint ranking from Tableau 8, with the additional constraint OK-σ, is used in Tableau 8 to test if the set of constraints is able to generate the grammatically optimal candidate.

Tableau 8. Gliding in Squliq Atayal.

OK-σ, No-Hiatus, Dep, Onset, NoDiph, Max-IO (Rt) >> Uniformity-IO >> Max-IO(μ)

/tbuci-un/	OK-σ	No-Hiatus	Dep	Onset	NoDiph	Max-IO (Rt)	Uniformity-IO	Max-IO(μ)
a. [tbu.ci.ʔun]			*!					
b. [tbu.ci.un]		*!		*!				
c. [tbu.ciun]					*!			
d. [tbu.cin]						*!		*
e. [tbu.cun]						*!		*
☞ f. [tbu.cjun]								*
g. [tbu.ciwn]	*!							*
h. [tbucun]							*!	*

Candidate (a) violates Dep, which is ranked higher as epenthesis is not the hiatus resolution in Squliq Atayal. Candidate (b) faithfully parses all the vowels, and it violates both No-Hiatus and Onset. Candidate (c) satisfies Onset, but violates NoDiph. Candidates (d) and (e) delete V_1 and V_2 respectively and simultaneously violate of Max-IO (Rt) and Max-IO(μ). Thus, (f) is the optimal candidate as it only violates the constraint in the lowest ranking. However, (g) is also ruled out because the syllable structure is not permitted in Squliq Atayal. The last candidate (h) has the identical surface form to (e). However, it is also less harmonic than (f), although coalescence is permitted in Squliq Atayal. In contrast, Isbukun Bunun allows both CGVC and CVGC. Candidates ruled out by OK-σ in Squliq Atayal are accepted in Isbukun Bunun. However, the data from Table 24 of Isbukun Bunun suffixed verbs do not contain any high vowel sequences, so the context does not lend itself to testing how the two conjunctions of high vowels perform in this language. The following table summarizes the hiatus resolution of the five languages discussed.

Table 24. Summary of hiatus resolution of ciNsenga, ChiShona, Luganda, Isbukun Bunun and Squliq Atayal.

	CiNsenga	ChiShona	Luganda	Isbukun Bunun	Squliq Atayal
DEP	Not allowed	Allowed	Not allowed	Not allowed	Not allowed
NO-HIATUS	Not allowed	Not allowed	Not allowed	Not allowed	Not allowed
ONSET	Not allowed	Not allowed	Not allowed	Not allowed	Not allowed
NODIPH	Not allowed	Not allowed	Not allowed	Not allowed	Not allowed
MAX-IO (RT)	Not allowed	Not allowed	Allowed	Not allowed	Not allowed
MAX-IO(μ)	Allowed	Allowed	Not allowed	Allowed	Allowed
SECARTIC	Not allowed	Not allowed	Allowed	Not allowed	Not allowed
V:	Not allowed	Not allowed	Allowed	Not allowed	Not allowed
OK-σ	N/A	N/A	N/A	Allowed	Not allowed
UNIFORMITY-IO	Not allowed	Allowed	Not allowed	Allowed	Allowed
OCP-PLACE	Not allowed	Not allowed	Not allowed	Not allowed	Not allowed

The comparison in Table 24 shows that glide formation of Isbukun Bunun and Squliq Atayal are very similar to ciNsenga and ChiShona. As mentioned earlier, Isbukun Bunun data do not contain any suitable context to examine the combination of two sequential high vowels. The table indicates that Isbukun Bunun shares the same set of constraint ranking with ciNsenga and ChiShona for glide formation of hiatus. OK-σ may not be applicable to the three Bantu languages, but the comparison still shows that these five languages share most of the constraints in glide formation. To sum up, (55)-(59) below indicates the three Bantu and two Formosan Austronesian languages share the same set of constraints, but with different rankings.

(55). CiNsenga constraint ranking of glide formation

NO-HIATUS, ONSET, NODIPH, V:, DEP, SECARTIC, UNIFORMITY-IO, OCP-PLACE >> MAX-IO (RT) >> MAX-IO(μ)

(56). ChiShona constraint ranking of glide formation

NO-HIATUS, ONSET, NODIPH, V:, DEP, SECARTIC, UNIFORMITY-IO, OCP-PLACE >> MAX-IO (RT) >> MAX-IO(μ)

(57). Luganda constraint ranking of glide formation

No-Hiatus, Onset, NoDiph, Dep, Max-IO(μ), Uniformity-IO, OCP-Place >> Max-IO (Rt), SecArtic, V:

(58). Isbukun Bunun constraint ranking of glide formation

No-Hiatus, Onset, NoDiph, V:, Dep, SecArtic, Max-IO (Rt), OCP-Place >> Uniformity-IO >> Max-IO(μ), OK-σ

(59). Squliq Atayal constraint ranking of glide formation

OK-σ, No-Hiatus, Onset, NoDiph, V:, Dep, SecArtic, Max-IO (Rt), OCP-Place>> Uniformity-IO >> Max-IO(μ)

It is mentioned earlier that glide formation is also one of the hiatus resolution in isiXhosa (Casali, 2011), so the same set of constraints is used and shown in the following tableau to show isiXhosa also shares the same set of constraints with different rankings.

Tableau 9. Glide formation in isiXhosa.

OK-σ, No-Hiatus, Onset, NoDiph, V:, Dep, SecArtic, OCP-Place >> Max-IO (Rt) >> Uniformity-IO >> Max-IO(μ)

/esisu-ini/	OK-σ	No-Hiatus	Onset	NoDiph	V:	Dep	SecArtic	OCP-Place	Max-IO (Rt)	Uniformity-IO	Max-IO(μ)
a. [esisujni]	*!										
b. [esisu.ini]		*!	*!	*!							
c. [esisi:ni]					*!						
d. [esisuʔini]						*!					*
e. [esil^{w}ini]							*!		*		*
f. [esisini]									*		*
☞ g. [esiswini]											*

Candidate (a) is ruled out because gliding of V_2 is not found in isiXhosa. Candidate (b) is also eliminated because it violates three high-ranked constraints. Gliding with compensatory lengthening of V_2 is also not found in isiXhosa, so candidate (c) is ranked out. Both candidate

(d) and (e) violates high-ranked constraints since epenthesis and secondary articulation are not the hiatus resolution in isiXhosa. Candidate (f) satisfied all high-ranked constraints, but it has more violations compare to candidate (g). Therefore, candidate (g) is the optimal candidate.

4.3.3 Vowel elision/coalescence

Table 26 from the previous section indicated that coalescence is not the hiatus repair strategy of ciNsenga and Luganda. However, it is the second strategy to resolve hiatus in Isbukun Bunun and Squliq Atayal. The section below will demonstrate some of the data of Isbukun Bunun and Squliq Atayal from Huang (2006), and some other selected Bantu languages.

Table 25. Coalescence of Isbukun Bunun verbs (Huang, 2006, p. 5)

	Underlying	Surface	Gloss
a	/tutu-un/	[tutún]	‘pour out’
b	/taʔaða-a/	[taʔaðá]	‘listen to’
c	/patliva-an/	[patliván]	‘make mistakes in writing’

Table 27 shows hiatus resolution in the cases where stem-final and suffix-initial vowels are the same. The surface form can be interpreted as a straight-forward deletion rather than coalescence. First of all, the Weight-to-Stress Principle requires the stress to fall in the prosodically weak position, so it is assumed that the two identical vowels coalesce and moras are retained. Secondly, Huang (2006) also points out the corresponding pair of Isbukun and Takituduh, a more conservative dialect of Bunun (60).

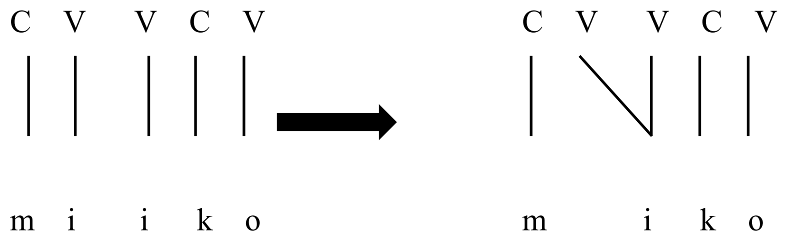
(60). “Child” in Isbukun and Takituduh.

Isbukun	Takituduh
[ʔuváð]	[ʔuvaʔáð]

“Child” in Takituduh shows two identical vowels with a glottal. It is likely that coalescence takes place after the loss of glottal in the diachronic phonology of Bunun, which leads to some of the exceptional final-stressed words in Isbukun (Huang, 2006, p. 6).

Luganda also has similar strategies to deal with two juxtaposed vowels. Casali (2011) mentions in his study that Twin Vowel Deletion is triggered in the sequences of /i+i/ and /u+u/ in Luganda, so a word like /mi-iko/ is surfaced as [mi:ko] ‘trowels’. The transformation of two identical vowels is explained in (61) below.

(61).



(Casali, 2011, pp. 25–26)

In addition, gliding of V_1 in the combination of /i+i/ and /u+u/ will result in [^{y}i] and [^{w}u] respectively, and violates OCP. Kadenge and Simango (2014) also provide an example of combination of /a+a/ in Luganda, as shown in (62).

(62).

Underlying	Surface	Gloss
/ba-a-lab-a/	[ba:laba]	‘they saw’

(Kadenge & Simango, 2014, p. 113)

(62) also shows deletion of one vowel and lengthening of the surface vowels in order to maintain the quantity of moras in the input. The constraint ranking of Luganda in Tableau 4, repeated here as (63), puts Max-IO(μ) in the higher ranking. Vowel lengthening is highly required, so the quantity of moras in the input is not affected.

(63). Dep, Onset, NoDiph, Max-IO(μ) >> SecArtic, NLV

(Rosenthall, 1997, p. 154)

Squliq Atayal also has coalescence. This occurs under two conditions: first, when the vowels are identical, and second, when the –VC suffix creates a falling-sonority sequence. This is shown in Table 26.

Table 26. Coalescence in Squliq Atayal verbs (Huang 2006, p. 12)

	Underlying	Surface	Gloss
a	/tbuci-i/	[tbuci]	‘to separate’
b	/pnbu-un/	[pnbun]	‘to cause to be sick’
c	/kita-an/	[kitan]	‘to see’
d	/soja-un/	[sojon]	‘to like’
e	/giba-un/	[gbon]	‘to embrace’

It was noted earlier that Isbukun Bunun obeys WSP, so the moras of the two underlying juxtaposed vowels must be retained. However, WSP is not applicable in Squliq Atayal, and no cross-dialectal comparison is found to support coalescence in Squliq Atayal. Whether coalescence or vowel elision is applied in candidates (a) to (c) is better explained with the reduction rule; it is shown in (26) and repeated here as (64).

(64). a. A deletion account:

	/kita$_1$-a$_2$n/			/kita$_1$-a$_2$n/
Reduction	kəta$_1$-a$_2$n		Deletion	kita$_2$n
Deletion	kəta$_2$n		Reduction	kita$_2$n
	[kəta$_2$n]			*[kita$_2$n]

b. A coalescence account:

	/kita$_1$-a$_2$n/	or		/kita$_1$-a$_2$n/
Reduction	kəta$_1$-a$_2$n		Coalescence	kita$_{1,2}$n
Coalescence	kəta$_{1,2}$n		Reduction	kəta$_{1,2}$n
	[kəta$_{1,2}$n]			[kəta$_{1,2}$n]

(Huang, 2006, p. 13)

The deletion account in (64a) explains that when reduction occurs before deletion, the surface form remains grammatical in Squliq Atayal, but ungrammatical when deletion takes place before reduction. In the coalescence account (64b), both ways of transformation result in identical surface forms. Therefore, coalescence is more suitable than deletion to account for the identical vowel repairing process in Squliq Atayal. Candidates (d)–(e) in Table 28 show another type of coalescence. In Isbukun Bunun, coalescence only occurs when two vowels are identical, but in Squliq Atayal, coalescence also occurs in the second condition when V_1 and

V_2 create a falling-sonority sequence. Table 27 shows the comparison of glide formation and coalescence, and their relationship with sonority.

Table 27. The comparison of glide formation and coalescence in –VC suffix in Squliq Atayal.

	Glide formation		Coalescence	
a	/hkani-an/	[hknjan] 'to walk'	/soja-un/	[sjon] 'to like'
b	/biru-an/	[birwan] 'to write'	/giba-un/	[gbon] 'to embrace'
c	/tbuci-un/	[tbcjun] 'to separate'		

To put it simple, in the context when the suffix is –VC and a high vowel follows a non-high vowel, it triggers coalescence. This further explains why /soja-i/ (in Table 23a, repeated here as (65) does not undergo coalescence, even it fulfills the requirement that the two vowels also form a falling sonority, because the suffix is not the –VC structure.

(65). Underlying Surface Gloss

/soja-i/ [sjaj] 'to like'

Coalescence in Table 26 (a, b) shows [a+u]→[o]. This is also found in ChiShona and isiXhosa. Harford (1997) identifies coalescence as a common phenomenon in Bantu languages, and the frequent combinations are discussed in (29) and repeated here as (66).

(66). a. a+a=a
b. a+i=e
c. a+u=o (Harford, 1997, p. 70)

In ChiShona, vowel coalescence involves the merging of two basic vowels /i,a,u/ to form a single vowel which is secondary, that is, either [e] or [o] (Kadenge, 2010, p.8). Coalescence is triggered when V_1 is /a/. When V_1 is either /u/ or /i/, glide formation or deletion is taking place to repair hiatus. Some linguistic data of coalescence in ChiShona are presented in the table below.

Table 28. Coalescence in ChiShona (Kadenge, 2010, pp. 8–9)

	Underlying	Surface	Gloss
a.	/sa+ini/	[seni]	like me (first person singular)
b.	/na+ini/	[neni]	with me (first person singular)
c.	/ɦa+itʃi/	[ɦetʃi]	this one
d.	/ɦa+iz̧i/	[ɦez̧i]	those ones
e.	/ra+iɗu/	[reɗu]	ours (5)
f.	/ka+iɗu/	[keɗu]	ours (cl 12)
g.	/ɦa+uju/	[ɦoju]	this one (cl 1)
h.	/ɦa+ujo/	[ɦojo]	that one (cl 3)
i.	/ɦa+urwo/	[ɦorwo]	that one (cl 11)

In Table 28, (a-f) and (g-i) show the coalescence pattern of /a+i/=[e], and /a+u/=[o] respectively. This type of coalescence appears to be very common in Bantu languages. IsiXhosa also has the same patterns of coalescence as that shown in (66). Examples are also provided below.

Table 29. Coalescence in isiXhosa (Casali, 2011, p. 19)

	Underlying	Surface	Gloss
a	/wa-inkosi/	[wenkosi]	'of the chiefs'
b	/wa-umfazi/	[womfazi]	'of the woman'

It is clear from Table 29 that coalescence is one of the hiatus resolutions in isiXhosa. According to Casali (2011), coalescence only triggers when V_1 is non-high and V_2 is high. There are also cases when two identical vowels appear as hiatus (/aɓa-akhi/→[aɓakhi]). In that case, elision is used to resolve the vowel sequence. Such a case is distinct from Luganda, Isbukun Bunun and Squliq Atayal as their surface vowels still maintain the quantity of moras in the underlying form, while isiXhosa chooses to delete the vowel in the sequence of two identical vowels.

After all, the discussion above illustrates that coalescence of Isbukun Bunun and Squliq Atayal is more similar to Luganda in the context where two vowels are identical. However, although coalescence in Squliq Atayal is limited to the –VC suffix form, the resultant after coalescence is identical to Bantu languages. Table 30 gives a comparison of different hiatus resolutions of identical vowels and [a+i]/ [a+u] combinations in these languages.

Table 30. Hiatus resolutions in Luganda, isiXhosa, ChiShona, Isbukun Bunun and Squliq Atayal.[8]

	Luganda	isiXhosa	ChiShona	Isbukun Bunun	Squliq Atayal
a+a	[a:] (E)	[a] (E)	[a] (E)	[á] (C)	[$a_{1,2}$] (C)
i+i	[i:] (E)	[i] (E)	N/A	N/A	[$i_{1,2}$] (C)
u+u	[u:] (E)	[u] (E)	N/A	[ú] (C)	[$u_{1,2}$] (C)
a+i	[i] (E)	[e] (C)	[e] (C)	N/A	N/A
a+u	[u] (E)	[o] (C)	[o] (C)	[aw] (G)	[o] (C)

4.3.4 Optimality Theory constraints of coalescence and vowel elision

Luganda has similar strategies to Isbukun Bunun and Squliq Atayal when dealing with two identical vowels: they all retain the quantity of moras from the underlying vowels. Compensatory lengthening is a typical characteristic of Luganda, so the quantity of moras are retained after the elision of V_1. IsiXhosa also has V_1 elision when responding to the identical vowels. In isiXhosa, as in many other Bantu languages, there is no vowel length contrast in words. All vowels appear as short vowels (Li, 2015), so the elision of V_1 does not trigger compensatory lengthening, and causes a mora loss. The combination of /i+i/ and /u+u/ are not applicable in ChiShona, but elision is also applied on /a+a/, which resembles isiXhosa. In this case, MAX-IO($_\mu$) is undominated in Luganda, Isbukun Bunun and Squliq Atayal, and dominated in isiXhosa and ChiShona. The following table shows how identical vowel sequence is solved in Luganda. The constraints OCP, MAX-IO and SECARTIC are used.

Tableau 10. Hiatus resolution of identical vowel sequence in Luganda.
OCP >> MAX-IO >> SECARTIC (Rosenthall, 1997, p. 159)

/mi+iko/	OCP	MAX-IO	SECARTIC
☞ a. [mi:.ko.]		*	
b. [m^yi:.ko.]	*!		*
c. [m^yi:.ko.]		*	*!

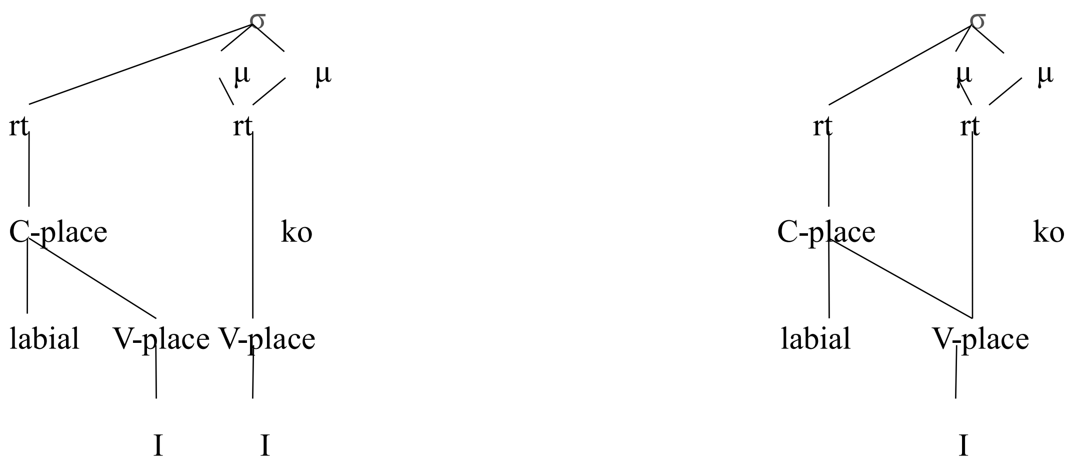
Secondary articulation is one of the hiatus resolutions in Luganda. In the case when two identical vowels co-exist (/i+i/), the surface form of /^{y}i/ could possibly occur. Tableau 10 above indicates that OCP is situated in the highest position in the ranking for banning the identical

8 E=Elision; C=Coalescence; G=Glide Formation

adjacent element. Candidate (b) crucially violates OCP and is thus eliminated. Candidate (c) satisfies OCP, but its multiple linking violates both MAX-IO and SECARTIC. According to Rosenthall (1997), the constraint SECARTIC is fatal in candidate (c) because the winning candidates, (a) and (c), both tie for satisfaction of the higher ranking constraints. (67) below presents the syllable structure of candidates (b) and (c).

(67). Candidates (b) and (c) from Tableau 10 (Rosenthall, 1997, p. 158)

Candidate (b) /m^{y}i:.ko./ Candidate (c) /m^{y}i:.ko./



This set of constraint ranking is also applicable to Isbukun Bunun and Squliq Atayal, and the tested result is shown in Tableau 11 and 12.

Tableau 11. Hiatus resolution of identical vowel sequence in Isbukun Bunun.
OCP >> MAX-IO >> SECARTIC, /tutu-un/

	OCP	MAX-IO	SECARTIC
☞ a. [tutún]		*	
b. [tutuun]	*!		
c. [tutuwn]	*!		
d. [tut^{w}un]	*!		*

SECARTIC might not be applicable in Isbukun Bunun since this language does not have this kind of features in its phonology. However, having OCP in the higher ranking ruled out all the fatal candidates. Candidate (a) only violates MAX-IO, which makes it the optimal candidate.

Tableau 12. Hiatus resolution of identical vowel sequence in Squliq Atayal.

OCP >> MAX-IO >> SECARTIC, /pnbu-un/

	OCP	MAX-IO	SECARTIC
☞ a. [pnbun]		*	
b. [pnbuun]	*!		
c. [pnbwun]	*!		
d. [pnb^{w}un]	*!		*

Candidate (a) in the table above is the optimal candidate as it only violates MAX-IO. Identical to the examples in Tableau 11, OCP ruled out all the candidates that try to preserve one of the vowels.

In ChiShona, vowel elision is triggered when V_1 is /i/ with a preceding consonant (Kadenge and Simango, 2014). The gliding of /i/ results in Cj, which is banned by the higher ranked constraint *COMPLEX (68), and secondary articulation creates palatalized consonants (C^js) (69), which are not found in the ChiShona consonantal inventories. ANCHOR L (70) is added to rank out any candidates that delete V_2.

(68). *COMPLEX: Complex onsets are prohibited.

(McCarthy, 2008, p.261)

(69). *C^j: Palatalized consonants are prohibited.

(Sibanda, 2009, p.48, Mudzingwa, 2010, p.19)

(70). ANCHOR L: Any root node at the left edge of a morpheme in the Input has a correspondent root node in the Output.

(Casali, 1998)

In isiXhosa, only a round V_1 undergoes glide formation before a following non-round vowel (Casali, 2011, p.18). In this case, *C^j is undominated in isiXhosa. ANCHOR L is also highly ranked because hiatus resolution targets V_1 only.

(71) Below is the constraint ranking of /i/ elision in ChiShona, and the same set of ranking is applicable for isiXhosa (71).

(71). ONSET, *COMPLEX, ANCHOR L, $*C^j$, >> MAX-IO (Rt) >> MAX-IO(μ)

(Kadenge and Simango, 2014, p.119)

Tableau 13. /i/ elision in isiXhosa.

ONSET, *COMPLEX, ANCHOR L, $*C^j$, >> MAX-IO (Rt) >> MAX-IO(μ)

/ndi-akha/	ONSET	*COMPLEX	ANCHOR L	$*C^j$	MAX-IO (Rt)	MAX-IO(μ)
a. [ndi.akha]	!*					
b. [ndjakha]		!*				
c. [ndi.kha]			*!		*	*
d. [nd^jakha]				!*	*	*
☞ e. [ndakha]					*	*

In Tableau 13, candidate (a) with vowel hiatus and fatally violates ONSET. Candidate (b) satisfied ONSET by turning V_1 into glides but fatally violates *COMPLEX. Candidate (c) deletes V_2 to satisfied ONSET and *COMPLEX but fatally violates ANCHOR L. Candidate (d) uses secondary articulation to avoid the violation of *COMPLEX but fatally violates $*C^j$, which palatalized consonant is not permitted in isiXhosa. The last candidate (e) is optimal. The elision satisfied all higher-ranked constraints and only violates the lower-ranked ones.

(72) is the constraint ranking of vowel elision involving post consonantal /a+a/ in ChiShona, and the set of ranking is also applied on isiXhosa (Tableau 14).

(72). ONSET, *COMPLEX, $*C^ʕ$, >> MAX-IO (Rt) >> MAX-IO(μ)

(Kadenge and Simango, 2014, p.119)

Tableau 14. /a/ elision in isiXhosa.

ONSET, *COMPLEX, $*C^ʕ$, >> MAX-IO (Rt) >> MAX-IO(μ)

/aɓa_1-$a_2$khi/	ONSET	*COMPLEX	$*C^ʕ$	MAX-IO (Rt)	MAX-IO(μ)
a. [aɓa_1.a_2.khi]	!*				
b. [aɓʕa_2.khi]		!*			*
c. [a$ɓ^ʕ$$a_2$.khi]			*!	*	*
☞ d. [aɓa_2.khi]				*	*

Candidate (a) fatally violates ONSET and is thus eliminated. Candidate (b) resolves vowel sequence with glide epenthesis of /ʕ/, and violates the higher-ranked constraint *COMPLEX. Candidate (c) utilizes secondary articulation and satisfied the other two higher-ranked constraint by turning V_1 into a pharyngealised consonants, but crucially violated $*C^ʕ$. Candidate (d), with elision of V_1, satisfied all high-ranked constrained, is the winning candidate.

Coalescence is one of the hiatus resolution in isiXhosa. The repairing strategy is triggered when V_1 is non-high and V_2 is high, the outcome is a [-high] version of V_2 (Casali, 2011, p.17). As mentioned previously, coalescence involve the merging of /a+i/ and /a+u/. Coalescence takes place in the combination of /e+i/, /e+u/, and /o+u/. For the vowel sequence of /o+i/, both glide formation and coalescence are triggered. (73) below listed the resultants of these combinations

(73). Hiatus resolution in isiXhosa.

a. a+i=e (coalescence)
b. a+u=o (coalescence)
c. e+i=e (coalescence)
e. e+u=o (coalescence)
f. o+i=we (coalescence and glide formation)
g. o+u=o (coalescence)

The comparative analysis up to this point shows that the same set of constraint rankings of vowel elision in ChiShona is applicable in isiXhosa. However, (73) shows more complex hiatus resolutions, especially in (73f) where two repairing strategies are both triggered. The existing constraint rankings of coalescence in isiXhosa were not found by the author of the present study. Therefore, constraints of Squliq Atayal from (58), with different ranking, are used to test if the grammatical candidate can also be identified in isiXhosa (Tableau 15). In addition, OCP-PLACE is added into the as /wu/ is not found from the existing data.

Tableau 15. Coalescence in isiXhosa.

OK-σ, No-Hiatus, Onset, NoDiph, V:, Dep, SecArtic, OCP-Place >> Max-IO (Rt) >> Uniformity-IO >> Max-IO(μ)

/wa-umfazi/	OK-σ	No-Hiatus	Onset	NoDiph	V:	Dep	SecArtic	OCP-Place	Max-IO (Rt)	Uniformity-IO	Max-IO(μ)
a. [wawmfazi]	*!										
b. [wa.umfazi]		*!	*!	*!							
c. [wu:mfazi]					*!			*!			
d. [wʕumfazi]						*!					*
e. [wˤumfazi]							*!		*		*
f. [wumfazi]								*!	*		*
☞ g. [womfazi]									*	*	*

Candidate (a) is considered to violate OK-σ as the structure of CVGC has not been found in the existing data by the author. Candidate (b) fatally violates three high-ranked constraints by preserving two adjacent vowels. Candidate (c) violates constraints V: and OCP-Place since vowel elision does not trigger compensatory lengthening of V_2 in isiXhosa, and /wu/ is also not found in the language. Candidate (d) and (e) both crucially violates high-ranked constraints as epenthesis and secondary articulation are not the hiatus resolution for isiXhosa. Candidate (f) satisfied other high-ranked constraints by deleting V_1. However, the candidate creates a /wu/ sequence, which also violates OCP-Place. Candidate (g) is the optimal candidate because it only violates the lower-ranked constraints.

It is mentioned earlier that isiXhosa has multiple hiatus resolution for the combination of /o+i/. Constraint ranking from above table is used again in Tableau 16 to show its capability of generating the optimal candidate.

Tableau 16. Multiple hiatus resolution in isiXhosa.

OK-σ, No-Hiatus, Onset, NoDiph, V:, Dep, SecArtic, OCP-Place >> Max-IO (Rt) >> Uniformity-IO >> Max-IO(μ)

/esilo-ini/	OK-σ	No-Hiatus	Onset	NoDiph	V:	Dep	SecArtic	OCP-Place	Max-IO (Rt)	Uniformity-IO	Max-IO(μ)
a. [esilojni]	*!										
b. [esilo.ini]		*!	*!	*!							
c. [esili:ni]					*!						
d. [esiloʔini]						*!					*
e. [esil^{o}ini]							*!		*		*
f. [esilini]									*		*
☞ g. [esilweni]										*	

Candidate (a) fatally violates OK-σ, so it is eliminated. Candidate (b) violates three high-ranked constraints by preserving hiatus. Candidate (c) violates constraints V:, and is also eliminated because vowel elision does not trigger compensatory lengthening of V_2 in isiXhosa. Candidate (d) and (e) both fatally violate high-ranked constraints since epenthesis and secondary articulation are not the hiatus resolution for isiXhosa. Candidate (f) satisfied all high-ranked constraints by deleting V_1. However, the candidate has more violation than candidate (g). Therefore, (g) is the optimal candidate.

IsiXhosa uses glide formation, coalescence, and vowel elision to resolve vowel hiatus, which has striking similarities to both Formosan Austronesian languages. The table above again explains that the same set of constraint, with different ranking, of other selected languages in the present study capable of yielding the optimal candidate in isiXhosa. However, the performance of hiatus resolution in ChiShona is relatively abundant as it has five different resolutions: glide formation, secondary articulation, elision, vowel coalescence, and glide epenthesis (Kadenge, 2014). Constraints discussed in the present study may not be sufficient to account for the hiatus resolutions in ChiShona, and it certainly needs more investigation and analysis to generate an integrated set of constraint rankings that will be able to satisfy all the morphosyntactic requirements of the language.

4.4 Summary

The first section of this chapter provided the phonological data of the selected languages from both Bantu and Formosan Austronesian language families. The second part of the chapter illustrated the comparative analysis of hiatus resolutions and constrain rankings of these selected languages. The analysis showed that the strategies these languages use to repair hiatus are highly similar. OT constraints from both language families were discussed and used as cross-examination. And more, the comparative analysis showed these languages shares the same set of constraints in specific hiatus resolutions.

Chapter 5: Conclusion

This chapter comprises a comparative analysis of hiatus resolution and OT constraints of the Bantu and Formosan Austronesian language families. The present study has so far discussed the similarities and differences of hiatus resolution amongst the selected languages and has carried out a cross-examination of the OT constraints, hence generating different rankings from the same set of constraints for these languages.

This study focused on the hiatus resolution of languages from the Formosan Austronesian and Bantu languages families. The two language groups are geographically distant from one another. Formosan Austronesian languages are one group of the Austronesian languages only spoken by indigenous people in Taiwan, while Bantu languages are spoken in Africa. However, the point where these two language families merge is Madagascar. The study did not go further into historical aspects to investigate the dispersal of these languages, nor did it investigate the influences Bantu languages have on Malagasy, which belongs to the Austronesian language family.

There are many languages that tolerate hiatus, and many others that do not. Studies have shown that most of the Bantu and Formosan Austronesian languages do not tolerate hiatus, and they use common repair strategies to preserve the surface monophthongal vowel: glide formation, coalescence, and vowel elision. Studies on hiatus resolutions tend to focus on comparative analysis within the same language family or dialects of the same language. This paper has tried to illustrate the similarities and differences in how hiatus is handled in the selected Formosan Austronesian and Bantu languages: Isbukun Bunun, Squliq Atayal, Luganda, isiXhosa, ciNsenga, and ChiShona.

The similarity is clearly seen in that all the selected languages have glide formation as one of their common hiatus resolutions. In ciNsenga and ChiShona, a high V_1 glides and causes the loss of its moraicity, and a non-high V_1 triggers vowel elision. Luganda has similar prevocalic distribution to ciNsenga and ChiShona where a high V_1 glides and a non-high V_1 deletes. In addition, glide formation and vowel elision result in compensatory lengthening of V_2. This indicates that vowel length is contrastive in Luganda. High vowels glide in both Isbukun Bunun and Squliq Atayal regardless in the position of V_1 or V_2. Glide formation is also found in isiXhosa. IsiXhosa differs from other selected languages in the study that target all high vowels, as glide formation only takes place when V1 is round /w/ before a following non-round V_2.

Coalescence is not the hiatus resolution for ciNsenga and Luganda, but the secondary repair strategy to resolve two underlying sequential vowels in Isbukun Bunun and Squliq Atayal. This process is similar to the process of vowel elision in Luganda in that it retains the quantity of underlying moras. It is due to the Weight-to-Stress Principle, which requires stress to appear in the prosodically weak position, so the two identical vowels coalesce in order to retain the quantity of moras. What is more, the pre-penultimate vowel reduction phenomenon in Squliq Atayal explains that reduction remains transparent in a coalescence, but opaque in a deletion. So, coalescence is the optimal strategy in dealing with two identical vowel sequences. Non-identical hiatus coalescence in Squliq Atayal has the same resultant as isiXhosa and ChiShona, in which a+u=o. In isiXhosa, coalescence is triggered when V_1 is non-high and V_2 is high: a+i=e, a+u=o, e+i=e, e+u=o, o+u=o. Interestingly, for the combination of o+i, both coalescence and glide formation are triggered (o+i=we).

All the above-mentioned indicates that the degree of similarity of hiatus resolution in these languages is relatively high. This study has also tried to generate a comparative summary of hiatus resolution, and conducted a cross-examination by using constraints from the different languages. These experimental trials have successfully yielded the optimal candidates. This test reaffirms the high degree of similarity among the chosen languages. Moreover, the comparative analysis has also shown that the selected languages share the same set of constraints in certain hiatus resolutions.

The results of this paper have highlighted the similarities of hiatus resolution within the two language groups. However, the two selected Formosan Austronesian languages in the study have only two repair strategies, namely glide formation and coalescence, while the hiatus resolutions in the selected Bantu languages are more diverse. For example, ciNsenga has three repair strategies (glide formation, secondary articulation, and elision), and ChiShona has five (glide formation, secondary articulation, elision, vowel coalescence, and glide epenthesis). Furthermore, isiXhosa also has three repair strategies to resolve hiatus, namely glide formation, coalescence, and vowel elision. The present study only considered the hiatus resolutions these selected languages have in common. The constraint rankings that were generated in the study may not wholly account for all the morphosyntactical restrictions, especially for ChiShona, due to its plentiful and complex hiatus repair strategies. However, these constraint rankings indicate that different rankings of the same set of constraints distinguish languages from one another. For purposes of further investigation, more languages from the Formosan Austronesian language family can be used for a more extensive comparative analysis. The findings could possibly represent an introduction to larger and broader studies on the linguistic aspects of Austronesian and Bantu languages.

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