VOWEL PHENOMENA OF GUANG LANGUAGES

by

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Abstract

The Guang language family of Ghana has received a fair amount of study over the past several decades. Snider's (1990b) work is the most extensive study on Guang phonology. The aim of this thesis will be to cite new information and build upon Snider's work to gain a better understanding of Guang phonology, specifically in relation to vowel systems and phenomena. Some of the most prominent phonological processes in Guang involving vowels include ATR and rounding harmony, and hiatus resolution. This study examines the consistencies and differences among Guang languages with regard to vowel phenomena. While some interesting variation does exist across the Guang language family, examination of available resources and data, along with some acoustic analysis, show that Guang vowel phenomena are generally consistent. The most important aspect that is consistent across Guang languages, despite differing analyses and descriptions, is that all exhibit nine-vowel systems.

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Acknowledgements

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1. Introduction

The Guang language family of Ghana may include as many as 19 languages. A significant amount of research has been done on the family, though some languages have received far more attention than others. This paper aims to describe what we have learned regarding Guang vowel phenomena since Snider's (1990b) dissertation on Guang phonology.

Why should Guang vowel systems be of interest at this point? Guang vowel systems contain several phenomena that are consistently of interest to phonologists, especially those studying African languages, including ATR harmony, rounding harmony, and hiatus resolution. I also wish to discuss the vowel inventories of Guang languages, as these have been analyzed several different ways. My aim is to build upon Snider's contribution and incorporate information from more recent works to provide a clear and comprehensive look at Guang vowel inventories and important phenomena

Additionally, the "history" of the study of Guang languages has been somewhat unusual. It covers a large span of time, including many different analyses. Some languages have a great deal of information available and some have none at all. One of the goals of this study is to discover some lessons for descriptive linguistics based on what has taken place in the study of Guang languages.

2. Background

The Guang languages are primarily spoken in Ghana, but some are spoken in parts of Benin, Togo, and Cote d'Ivoire (Snider 1990b: 3). The Glottolog (glottolog.org. Hammarström et al. 2019) lists 19 Guang languages, several of which have no available resources. The table below lists the 13 Guang languages included in this study, along with their sub-grouping, and where they are spoken.

Table 1 Guang languages included in this study

Language	Sub-group	Country
Chumburung	North Guang	Ghana
Dompo	North Guang	Ghana
Foodo	North Guang	Benin
Gichode	North Guang	Ghana
Gonja	North Guang	Ghana
Krachi	North Guang	Ghana
Nawuri	North Guang	Ghana
Nkami	North Guang	Ghana
Nkonya	North Guang	Ghana
Cherepong	South Guang	Ghana
Efutu	South Guang	Ghana
Gua	South Guang	Ghana
Larteh	South Guang	Ghana

2.1 Taxonomy of Guang languages

Snider (1990b) has grouped Guang languages into North Guang and South Guang as well as smaller subgroups. Figure 1 represents the taxonomy given by Snider for the languages discussed in this paper. Snider developed this taxonomy based on shared phonological innovations between Guang languages.

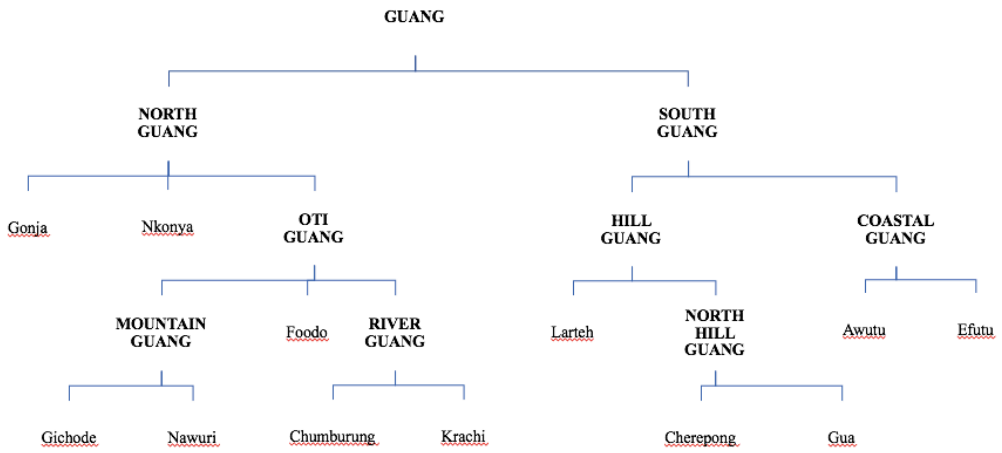

Figure 1 Snider's taxonomy of Guang languages

The following is a slightly updated version of this chart based on relations given from Glottolog (Hammarström et al. 2019). It lists fifteen North Guang languages and four South Guang languages. I have not included all of the languages listed, only the ones which are referenced in this paper. Note the inclusion of Nkami and Dompo, which have only been recognized as existent and part of the Guang language family fairly recently.

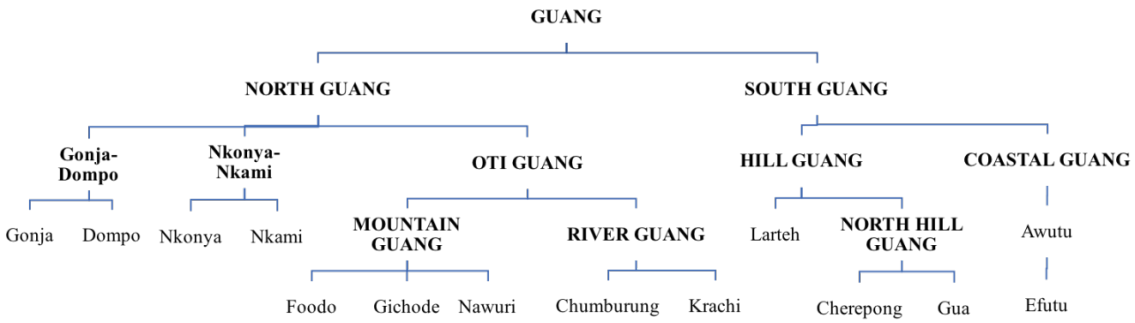

Figure 2 Guang subgroupings from Glottolog

There has been some disagreement on these groupings. Asante (2017: 85-87) presents a detailed argument for Nkami belonging to South Guang. Peacock (2007: 1) uses the classification given by Snider, but in a footnote he recognizes recent work might contradict this and place Nkonya with the South Guang language. Snider (1990b: 46) acknowledges similarities between Nkonya and South Guang, but believes Nkonya simply borrowed these traits from South Guang, and not that Nkonya has experienced the same historical changes as the South Guang languages. Despite variations between Nkonya and Nkami and the North Guang languages, Snider's reconstruction remains the most reliable information for Guang language groupings.

2.2 Previous work in Guang

There are a considerable number of works published on Guang languages, though they vary greatly in scope and depth. The most comprehensive work on Guang phonology, or Guang

languages in general, is Snider's (1990b) *Studies in Guang Phonology*. It is presented as a collection of articles that are published elsewhere (Snider: 1984, 1985, 1986, 1988, 1989b, 1989c, 1990a, 1990c, 1990d). Snider provides some background on Guang languages and an overview of the sound systems. He has also reconstructed the sounds of Proto-Guang. Included in this work is a North Guang comparative wordlist (also published separately as Snider 1989a) consisting of about 1000 words. This study provides a lot of valuable information in regard to Guang phonology. However, there is a focus on Chumburung over other Guang languages.

Next to Snider, Casali has written the most on Guang languages, with a primary focus on Nawuri. His study, *Nawuri Phonology* (Casali 1995b), is one of the most in-depth looks at the phonology of a Guang language. Casali has also written more typological and theoretical works in which he includes data from several Guang languages.

Significant works from before Snider's dissertation include Painter's (1970) book on Gonja, along with his work on Gua (1971). Dakubu's (1988) *The Languages of Ghana* has also been an important resource. It provides general information on several Guang languages, though it does not go into much depth. Other important works on Guang include Reineke (1972) on Nkonya, Lenwah (1979) on Gichode, and Bramson (1981) on Cherepong. Hansford also published a dissertation on Chumburung in 1990. There are some Guang resources which I have not accessed or made reference to in this study, but have historically been important in the study and description of Guang languages. These include Cleal (1974), Frajzyingier (1965), Painter (1967, 1972), Stewart (1966), and Westermann (1922).

Since Snider's dissertation (1990b), a good deal more has been published on Foodo, Gua, Nkonya, Efutu, Gonja, Nkami, and Dompo. Plunkett (1991, 2009) and Peacock (2007) have provided some of the most extensive works on Foodo and Nkonya, respectively. Obeng (2008)

and Agyeman (2016) have both published significant works on Efutu, though neither has a primarily phonological focus. The study on Gonja by Nelson et al. (2016) is another significant resource, as well as Akanlig-Pare and Asante's (2016) work on Nkami. Again, the aim of this study is to reference these more recent works in an updated comparative study of Guang vowel phenomena.

3. Guang vowel inventories

3.1 Overview of Guang vowel inventories

Historically for Guang languages, there have been a variety of reports regarding vowel inventories. While many of the languages have been described as having nine vowels, some have been said to have seven or ten. Today, most of the evidence suggests that these languages have nine-vowel systems, usually with a [+ATR] allophone of /a/, as well as long vowels. The basic inventory is /i, ɪ, e, ɛ, a, ɔ, o, ʊ, u/.

Snider (1990b: 12-13) provides a breakdown of Guang vowels based on his reconstruction of Proto-Guang. He argues that Proto-Guang had a system of seven oral and five nasal vowel phonemes for roots, with a slightly different set for prefixes. The list of root vowel phonemes looks similar to what we see in present day Guang, but is missing /e/ and /o/. Over time the nasal vowels merged with the oral vowels in North Guang languages and were no longer contrastive. Nasal vowels remain contrastive in South Guang languages. Snider then says for Chumburung, /ɛ/ became /e/, and /ɔ/ became /o/ only in [+ATR] contexts. This left a gap which was filled in again by /ɛ/, though he notes this is the least common vowel in Chumburung. Snider (1990b: 103) describes a historical change which only occurred in the vowels of Larteh. Root-finally /ɛ/ and /ɔ/ became /e/ and /o/. However, elsewhere it appears /ɛ/ and /ɔ/ remain intact. Ansah (2012) confirms a nine-vowel system for Larteh.

The following are representative of the variety of reports that exist about Guang vowel inventories. I include these in order to depict where some of the disagreement lies as well as to show how this has been an issue throughout the study of Guang languages and is continuing in some areas:

1. Gonja was described as having seven vowel phonemes by Painter (1970), but Nelson et al. (2016: 113-114), along with Snider (1990b), argue for nine, noting that Painter's seven-vowel analysis was common for the time. That is, around the time that Painter's work was published, 1970 and earlier, many Guang and Ghanaian languages were interpreted to have seven vowels. Nelson et al. believe these common misanalyses to be due to the difficulty of distinguishing [ɪ] and [ʊ] from [e] and [o], which I will discuss in Section 2.4.

2. Dakubu (1988: 82) stated that Gonja, Gichode and Nkonya each had only seven vowel phonemes. She notes some disagreement about Awutu, whether it has seven or nine vowels, and states that Krachi and Hill Guang have ten vowel phonemes.

3. Very little research has been done thus far on Dompo. Blench (2015: 5) states that it "probably has seven phonemic vowels." He does not include /ɪ/ and /ʊ/ (2015: 5).

4. Reineke (1972: 16) reported that Nkonya had seven oral vowels and seven nasal vowel phonemes. Peacock (2007: 4) reports a nine-vowel system for Nkonya, along with phonemic long vowels and phonemic nasal vowels for all nine. He provides clear examples to support the phonemes he claims, giving minimal pairs for the oral vowels and nasal vowels as well as showing contrast between ATR pairs (2007: 14-15).

5. Sherwood (1982: 42) describes Nawuri with ten vowel phonemes. She notes a [+ATR] allophone of /a/. The tenth phoneme she describes is /ə/. Casali (1995b)

describes a nine-vowel system for Nawuri. He notes [ə] may occur as a centralized allophone of a front vowel.

Can we safely assume that all Guang languages have nine-vowel systems? Casali seems to adopt this position, and most recent reports agree. There are a few studies that still show ten-vowel systems. Obiri (2013: 35) and Animah (2015: 32) both find ten vowel phonemes in Gua and Cherepong, including a low [+ATR] vowel /æ/. Based on examples from these works, it is not clear if [æ] ever occurs in unpredictable environments. Animah has very few examples of [æ], but Obiri has several. A large majority of these are word-initial in a [+ATR] word, but he does have a few transcriptions with [æ] word-finally. This is generally not expected in Guang languages. These transcriptions may be inaccurate, or they may show that [æ] is in fact contrastive. There are works (Obeng 1995, Bramson 1981) on both of these languages that claim only nine vowel phonemes. Despite the fact that Obiri and Animah's reports are more recent, there seems to be no definitive evidence of a Guang language with any system other than nine-vowels.

3.1.1 Nasal vowels

Snider (1990b: 119) shows that North Guang languages experienced a change from Proto-Guang which caused only non-nasal vowels to follow non-nasal consonants. This meant nasal vowels were no longer contrastive, so North Guang languages do not have separate phonemes for nasal vowels. Based on Snider's analysis it would seem that South Guang languages have maintained contrastive nasal vowels. It seems that a different historical change brought nasal vowel phonemes back to Nkonya, Nkami, and the South Guang languages (Snider 1990b: 111, 120). Peacock (2007: 14-15) shows that Nkonya has nine contrastive nasal vowel phonemes, and provides minimal pairs for each of these except /e/ and /ẽ/. Nkami (Akanlig-Pare and Asante 2016: 23) exhibits at least seven nasal vowels, all but /ẽ/ and /ɔ̃/. Both Obiri (2013)

and Animah (2015) show seven nasal vowel phonemes for Gua and Cherepong. These are /ĩ/, /ɪ̃/, /ɛ̃/, /ã/, /ɔ̃/, /ʊ̃/, and /ũ/. Agyeman (2016: 68) finds eight nasal vowels in Efutu, including /ɛ̃/. The following are examples from Peacock displaying contrast between nasal and oral vowels.

(1) Examples from Nkonya (Peacock 2007: 14-15)[1]

a. [èlíʔ] 'funeral' vs [èlî] 'poison'

b. [bíʔ] 'know' vs. [bɪ̀ʔ] 'sew'

c. [ìbú] 'hut' vs. [ìbʊ́] 'well'

d. [fʊ́ʔ] 'breathe' vs. [fʊ̀ʔ] 'reach'

e. [dʒòʔ] 'wait' vs. [dʒɔ̀ʔ] 'perch'

f. [fɛ́ʔ] 'sell' vs. [fɛ̀ʔ] 'blow'

g. [sɔ̀ʔ] 'try' vs. [sɔ́:] 'just, only'

h. [ìláʔ] 'behavior' vs. [ìlɑ́ʔ] 'deep gorge'

3.1.2 Long vowels

It appears that all Guang languages exhibit phonemic long vowels (Casali 1995b: 21). Nelson et al. (2016: 124) note that Painter's study (1970) did not mention long vowel phonemes in Gonja, though they are reported for all other North Guang languages. While the authors do not find any exact minimal pairs for length, citing Snider's North Guang wordlist and their own analysis (including measuring duration) they conclude that Gonja has contrastive long vowels as well. The following are examples of long vowels in Gonja.

(2) Examples from Gonja (Nelson et al 2016: 125)

a. [nèèrííʔ] 'to diminish'

b. [fɛ̀ɛ̀tí] 'monkey'

[1] I have included tone markings where they have been provided, but they are not included in every work I reference, and are not consistently marked in some sources.

c. [bɔ̀ɔ̀ɾɛ̀] ‘rain’

d. [kóólí] ‘to heap up’

e. [bááɾʊ̌] ‘news’

The following are examples of long vowels in Nawuri and Nkami. Akanlig-Pare and Asante were able to find minimal pairs for length in Nkami.

(3) Examples from Nawuri (Casali 1995b: 22)

a. [bɪ:la] ‘learn’

b. [ku:ri] ‘pig’

c. [pa:la] ‘borrow’

(4) Examples of minimal pairs from Nkami (Akanlig-Pare and Asante 2016: 24)[2]

a. [si] ‘abandon,’ [si:] ‘accompany’

b. [lɪ] ‘resemble/pass/river,’ [lɪ:] ‘mention’

c. [sɛ] ‘if,’ [sɛ:] ‘drain off/sweep away’

Acknowledgement of long vowels seem less consistent in some of the descriptions of South Guang languages. Obeng (2008: 4) does state there is a long vowel for each vowel phoneme in Efutu. Others do not describe these phonemes but examples appear to show their existence in Cherepong, Gua, and Larteh. Obiri (2013: 39), however, claims that vowel length is only contrastive word-initially in Gua.

Snider (2019) has recently published a study on long vowels in Chumburung. He finds that long vowels are perceived longer and measure longer than regular vowels. However, he does note an interesting occurrence, which we see in several Guang languages. Long vowels phrase-finally will be followed by a glottal stop. In this case, they measure shorter than a word-medial

[2] It should be noted that word-final long vowels are often followed by a glottal stop, utterance-finally, in Guang languages (Casali 1995). These are likely to occur in Nkami though they have not been transcribed here.

long vowel and a phrase-final regular vowel. Regular vowels have a shorter duration than long vowels word-medially, but they become lengthened phrase-finally. Word medially, long vowels averaged 28 milliseconds longer than regular vowels, but phrase-finally regular vowels averaged 25 milliseconds longer than long vowels. This is due to lengthening of the regular vowel utterance-finally, and the addition of the glottal stop following a long vowel utterance-finally. Snider states that the glottal stop occupies the second mora of the long vowel, so utterance-finally the vocalic portion of an underlying long vowel will only be a single mora in the surface form. We will see this phenomenon in other Guang languages in Section 5.

3.2 Centralization

The phenomenon of centralization of front vowels in Guang should be noted. Snider (1990b: 11-13) describes in Proto-Guang, as well as presently, the front vowels are in complementary distribution with central counterparts. He states that the front vowels occur root-finally and their central variants occur root-medially. Casali (1995b: 16) clarifies further that the front vowels will become centralized if they are short and occur between two consonants. Both Snider and Casali have described distinct centralized allophones for each front vowel. Some Guang linguists have accounted for this centralization in their transcriptions, while others have not. The central vowels have sometimes been transcribed as [ə] and considered to be a tenth phoneme. The centralization of Guang vowels, while a prominent phenomenon, does not have much bearing on the other processes I will discuss.

3.3 The acoustics of Guang vowels

Acoustic data is of interest due to the aforementioned issues of determining vowel inventories and the closeness of certain vowels. This issue is discussed in greater detail in Section 2.4. Acoustic measurements cannot provide all of the answers, as part of the problem is that certain phonemically distinct vowels have formant values that measure very closely

together. However, observing similar patterns across languages provides some clarity. Acoustic measurements and patterns of [+ATR] and [-ATR] vowels are also of interest in discussing the [+ATR] allophone of /a/ (Section 3.3).

Casali (2002), Anderson-Stalwart (2006), Painter (1970), and Nelson et al. (2016) have conducted acoustic studies on Guang languages: Nawuri, Foodo, and Gonja. (I've included data here from Nelson et al. over Painter, as his description does not include [ɪ] or [ʊ].) Obiri-Yeboah, Myers, and Berkson (2018) have recently conducted some innovative acoustic studies on Gua vowels. Their work and level of detail is beyond the scope of this paper; however, they do provide average formant values for the vowels, including the allophone of the low vowel. This is the only source I have found which includes an average for the allophone. Based on the findings of these studies, some generalizations can be made about the acoustic measurements of Guang vowels. Added to this discussion will be the results of my own measurements of Nkami data (described below).

Table 2 Formant averages of Guang vowels

Language	Nawuri[3]		Gonja		Foodo (Males)		Foodo (Females)		Gua		Nkami (Female)	
Average values (Hz)	F1	F2	F1	F2	F1	F2	F1	F2	F1	F2	F1	F2
i	280	2075	266	1996	323	2103	335	2393	275	1950	325	2440
ɪ	352	2075	377	1831	442	2038	563	2288	420	1710	511	2180
e	351	2100	363	1866	437	2064	551	2020	355	1895	478	2185
ɛ	545	1905	479	1717	639	1839	703	1953	510	1650	701	2052
a̟	-	-	-	-	-	-	-	-	570	1450	739	1866
a	850	1400	591	1517	862	1441	927	1544	770	1320	947	1665
ɔ	550	875	492	1063	638	1010	757	1269	550	950	679	1109
o	357	865	355	1037	459	995	588	1267	470	1105	487	1078
ʊ	404	800	361	955	469	854	554	1054	385	950	522	1070
u	315	833	274	1150	365	776	356	1032	320	1300	350	1222

[3] The values in Table 2 for Nawuri and Gua are estimates based on formant plots from Casali (2002: 17) and Obiri-Yeboah et al. (2018).

Casali took formant averages of long vowels in Nawuri and then calculated total averages from four adult male speakers. Nelson et al. took formant measurements and calculated the averages for each vowel based on data from a single adult male speaker. Anderson-Stalwart (2006) listed formant averages from four different Foodo speakers individually, two men and two women. I divided the Foodo data into two sets, the averages from the male speakers and the averages of the female speakers, since these measurements can be quite different due to vocal tract length. The averages from Obiri-Yeboah et al. are from measurements made of the author's own speech. Finally, I made the Nkami measurements from recordings of a single female speaker.

There are a few patterns that can be noted from these numbers. First is the pattern that [e] and [o] will have lower F1 averages than [ɪ] and [ʊ]. This is fairly consistent throughout this table. This pattern is found in many nine and ten vowel languages (Starwalt 2008: 9). For every language, the average F1 of [e] is lower than the average F1 of [ɪ], even if only marginally so in most cases. The Gua averages and those of the Foodo female speakers show [ʊ] to have a lower F1 average than [o]. Elsewhere, [o] has a lower F1 average. Also note that measurements from female speakers will have a larger range and generally higher F1 values.

The formant plot below is of the average formant values of vowels collected from two female Foodo speakers. I include this to compare with the formant plot of the measurements I have made from the Nkami data, as the Nkami speaker was also female.

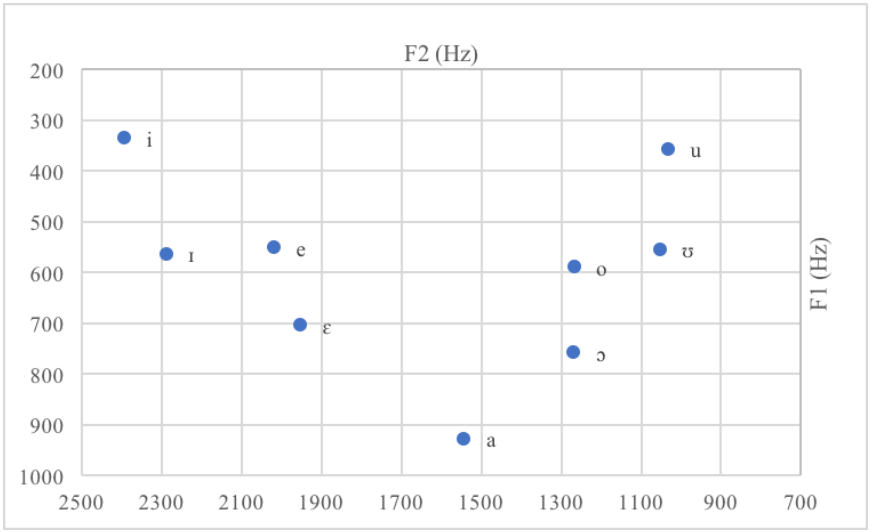

Figure 3 Vowel Formant Plot of Foodo female speakers from Anderson (2006)

I have taken vowel measurements from recordings of a single female Nkami speaker. I used Dekereke software running with Praat to make these measurements.[4] This data, a word list of 225 words with recordings, was collected by Casali and Peacock in Ghana in 2005.[5] Casali made the transcriptions. The plot below shows the average formant values from these measurements for the nine vowel phonemes and the allophone of /a/.

[4] Dekereke software can be accessed at casali.canil.ca. I made these measurements using the vowel formant analysis tool within the Dekereke program. This tool uses the Praat program to analyze recordings. Praat formant settings used were: Maximum formant – 5500 Hz, Number of formants – 5.0.

[5] Thanks are due to the Nkami speaker, Mrs. Comfort Akumah (name used with permission), who pronounced the examples in these recordings.

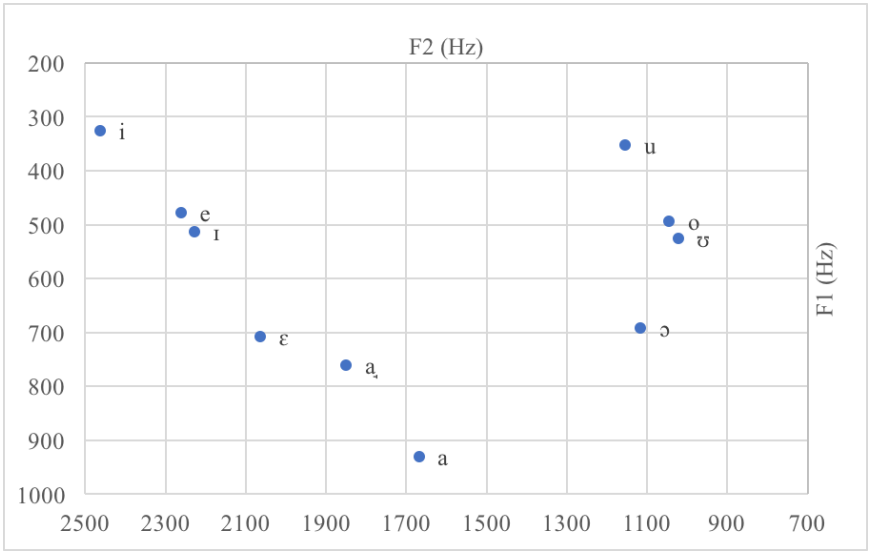

Figure 4 Formant plot of Nkami vowels

My results more or less aligned with the averages from other Guang languages. The pairs [ɪ] and [e], and [ʊ] and [o] are each very close to each other in the plot. This plot shows a greater range of values than some of the others, but the relations between vowels are quite similar. Issues of the low vowel and its allophone are presented in Section 3.3.

It may be worth noting that the F1 measurements of the [-ATR] vowels in Nkami are, on average, almost 200Hz higher than their [+ATR] counterparts. This may be especially noteworthy as the pattern appears to be consistent for [a̟] and [a], where there is data. Values in other languages show similar patterns (e.g. the range of the Gonja values is smaller, so the pairs are 110Hz different, on average). It also appears that a language may show similar range of difference between the [i]/[ɪ] and [u]/[ʊ] pairs, and another range for the difference between the [e]/[ɛ] and [o]/[ɔ] pairs (e.g. in the Nawuri measurements, [i]/[ɪ] and [u]/[ʊ] are each about 80 Hz different, while [e]/[ɛ] and [o]/[ɔ] are each about 190Hz different.) These numbers as averages are not highly conclusive of anything, but I found the general patterns helpful, especially in trying to identify the range for [a̟] in Nkami.

As Casali (2002: 17) noted considerable differences among the averages he calculated from different speakers in Nawuri, it should be noted that some of these averages above are compiled from multiple speakers, and some come from a single speaker. F1 values will be higher for female speakers. As we are just comparing the average measurement for each vowel, this should not have any significant effect on this analysis.

3.4 The low vowel and its allophone

Should [ạ] (symbolized as [æ] in some works) be considered an allophone of /a/ in Guang languages and not a phoneme? Most linguists who have worked on Guang have discovered that this sound only occurs in predictable, [+ATR] environments. I also found this to be the case in the Nkami data I analyzed. [ạ] occurred in predictable and consistent environments. Because of this, it is not analyzed as a separate phoneme.

Nelson et al. (2016: 120, 130) have conducted some acoustic analysis of /a/ in Gonja. They found that the allophone [ạ] has lower F1 values, falling in a range of about 400-550Hz, in contrast with around 600 Hz and higher for [a]. Anderson-Stalwart's acoustic study of Foodo (2008) did not include any analysis of [ạ]. She follows Plunkett's lead, stating, "there is no known [+ATR] variant of /a/ in Foodo" (2008: 22). As noted above, Obiri-Yeboah et al. (2018) have included the allophone in their acoustic studies of Gua.

I analyzed data from a set of 225 Nkami words with transcriptions made by Casali. For comparability, I took measurements of the low vowel word-initially. From this smaller set, I found 12 words beginning with [ạ] and 28 beginning with [a]. All of the occurrences of [ạ] came before other [+ATR] vowels. There are two words with [ˉATR] vowels for which the word-initial [a] appears to measure in the range of [ạ]. These are transcribed [aɲɔ] and [aɲɛsɪ]. Both Peacock (2007) and Akanlig-Pare and Asante (2016) have noted a correlation between voiced palatal sounds and [ạ], though they only cite this phenomenon for a low vowel following a

voiced palatal sound. Perhaps these word-initial low vowels may be experiencing some gradient effect. For the F1 measurement of [ạ] I found a range of 549-985Hz and for [a] and a range of 674-1146Hz. Like other pairs of [+ATR] and [-ATR] vowels, the ranges of these two have some overlap. It should be noted that these measurements may contain some errors on my part, or due to issues within the program or with the recording. I took note of the F2 measurements as well. Most of the literature describes the [+ATR] allophone to be somewhat fronted, and higher F2 correlates with frontness. The average F2 value for [ạ] is only about 200Hz higher than the average for [a], so perhaps this is not that significant of a difference, but it follows the trend of the other pairs of Guang vowels.

Figure 5 depicts the F1 and F2 values I found of the Nkami word-initial low vowels.

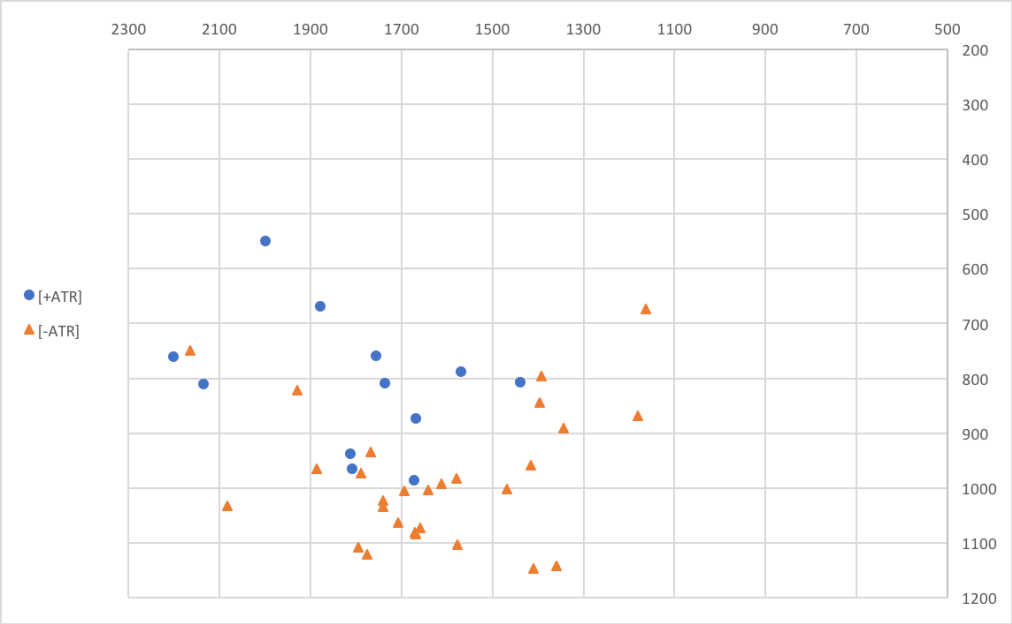

Figure 5 Scatter plot of [ạ] and [a] in Nkami

Though there is some overlap, there are clear trends for both sounds. A T-test shows a p value of .0002, indicating that it is not by chance that these sets have different averages.

It makes sense why several have labelled this allophone as [æ] as it would have similar formant measurements to those we see here for [ą]. From these word-initial vowels, the average formant values I found for [ą] are F1 809 Hz, F2 1807 Hz, and for [a] F1 981 Hz, F2 1629 Hz.

These findings are of interest as very little acoustic analysis has been conducted on the low vowel in Guang languages. These measurements show that there is a difference between [a] and its [+ATR] allophone. Analysis of the words containing [ą] show that it does occur in predictable contexts, and is clearly an allophone and not a phoneme. These results help to clarify remaining questions regarding the low vowel and Guang vowel inventories.

This conclusion is also interesting as Akanlig-Pare and Asante (2016: 25) have stated about Nkami: "the [-ATR] low vowel /a/ does not have a [+ATR] phonetic variant; it is always realized [-ATR] irrespective of the ATR status of the vowels it collocates with." This statement does not align with my findings from Nkami data. In [+ATR] environments the low vowel measures as [+ATR], as we would expect. The scatter chart displays the different ranges, and the difference is even clearer when comparing the average formant values of each. These findings may also lead us to believe that this allophone exists in other Guang languages where it has not been noted, such as Foodo. Plunkett (1991) has noted that any difference between /a/ and an allophone is very difficult to hear in Foodo. We will look at issues of perception in the following section (3.4). I would argue it is highly valuable to conduct acoustic study on the low vowel as the most definitive way to determine the existence of a [+ATR] allophone.

3.5 Issues of vowel perception and voice quality

Several linguists have addressed this "problem" of the acoustic similarity of [e] to [ɪ] and [o] to [ʊ], which we see in the formant averages and plots above. Some have also noted that [ą] and [a] are difficult to distinguish. The acoustic information above shows that the ranges of these vowels will overlap significantly with each other. One could not simply look at the formant plot

of one of these vowels and determine which one it is. This has led Casali and others to believe that there must be some voice quality difference that allows hearers to distinguish these vowels.

Painter (1971: 243) concludes that "breathy" is the best quality to listen for to identify [+ATR] and "choked" is the best for [-ATR]. Other linguists have relied on these or similar descriptors. Casali (2002: 14) acknowledges that it took him some time working in Nawuri before he could easily make this distinction.

Starwalt (2008: 374) notes that while F1 measurements can help distinguish between [+ATR] and [-ATR] pairs, these do not help distinguish between "cross-height vowel pairs, e.g. [e] vs. [ɪ]." She completed a study (Anderson 2006) of Foodo speakers to better evaluate ways to distinguish these vowels. She took measurements of the "center of gravity," which is a measurement of the spectral mean. She found that this measurement gave fairly consistent results from four Foodo speakers. [+ATR] vowels had lower measurements than [-ATR] vowels (2006: 4). There do not seem to be any other studies of Guang which employ this measurement.

Nelson et al. (2016: 120-121) relied on harmonizing affixes to help establish this distinction as they found the difference of ATR quality was easier to hear in affixes than that in the root. They also noted that native speaker intuition is helpful in this situation.

Akanlig-Pare and Asante (2016: 23) addressed this issue (the difficulty to distinguish [+ATR] vowels from [-ATR] vowels) very briefly in their paper on Nkami, saying, "We suspect that these observations are made by non-native ATR language speakers at the initial stages of fieldwork on ATR harmonizing languages." They seemed somewhat surprised that this was an issue, stating that in Nkami "/ɪ/ and /ʊ/ are highly distinct as there is no difficulty in identifying them from adjacent height vowels /i, u, e, o/."

A recent study by Rose et al. (2019) appears to contradict Akanlig-Pare and Asante's (2016) idea that [+/- ATR] vowels are not difficult to distinguish for native speakers. Rose et al. conducted a study with 41 Akan speakers to evaluate their ability to distinguish vowel pairs. Most of the subjects were speakers of the Asante dialect of Akan. The recordings for the study were provided by a native speaker of both Gua and Akan. These consisted of series of CV syllables, which were not necessarily words. The subjects were told the recordings were not their language. The participants were asked to listen to recordings and state whether the vowels in a set were the same or different.

For the analysis, Rose et al. broke pairs of vowels into categories: point vowels, which are the most different from each other (e.g. [i] and [u], [u] and [a]), ATR pairs (e.g. [e] and [ɛ], [ạ] and [a]), height contrasts (e.g. [i] and [e], [ʊ] and [ɔ]), and ATR and height contrasts. This final category is the one we have been discussing, and which historically has caused the most difficulty. These pairs are [ɪ] and [e], [ʊ] and [o], and [ɛ] and [ạ]. The results of the test are very interesting. For point vowels subjects were 97.5% accurate, for ATR pairs 95.75%, for height contrasts 90.25%, but for ATR and height contrasts speakers achieved only 23.75% accuracy. It is very interesting to view these numbers within a category breakdown. The first three categories show a little variance between each. The subjects had the highest level of accuracy with the category of vowels with the greatest degree of difference (e.g. [i] and [a]). They had slightly more difficulty distinguishing pairs with height contrast. These are all still very high and acceptable rates of accuracy. So the large drop off to the final category is remarkable, showing that speakers accurately distinguish these pairs less than a quarter of the time.

Rose et al. present some possible reasons for these results, citing potential flaws of the test and noting that the subjects were told the recordings were in a different language. The

authors also note that low frequency of [e] and [o] in mono-syllables in Akan may have contributed to these results. Still, these results seem to prove the difficulty, cited by many, of hearing the difference between these vowel pairs, and discount the idea that the difference is perfectly clear to native speakers. The study shows [ɪ] and [e] is the most difficult pair to distinguish, with only a 17.5% accuracy rating. [ʊ] and [o] had a 31.25% accuracy rating. As Plunkett and others have stated that it is difficult to hear any difference between [ạ] and [a], it is noteworthy that subjects did not have trouble distinguishing this pair. It had a 99% accuracy rating, which was second highest in the study after [a] and [u]. Where they did struggle was with the pair [ɛ] and [ạ][6] which had only about 22% accuracy. Again, like [ɪ] and [e], and [ʊ] and [o], [ɛ] and [ạ] are acoustically close in Akan, and are relatively close in formant values in the Guang data we have for [ạ]. It makes more sense that this is the difficult pair to distinguish. Average values for [ạ] and [a] are not very close acoustically in Akan and the Guang languages, though their plots will overlap, as with other ATR pairs.

The results of this study are for Akan and not a Guang language, however it seems likely one would find a similar outcome in Guang. This is especially interesting to note with regards to how Guang and other vowel inventories have historically been misanalysed. It gives support to the idea of voice quality along with other clues being necessary to distinguish certain vowels, as these levels of accuracy are very low for the most difficult pairs.

I tried to observe this phenomenon with the Nkami recordings I analyzed. My experience is very limited, but I would say most instances of [e] and [ɪ] sounded distinct to me, however [o] and [ʊ] sounded closer together and more difficult to distinguish. At least for some [-ATR] words I felt I could hear a more "choked" voice quality.

[6] The [+ATR] allophone of /a/ in Akan has been found to be very close to [ɛ] in a formant plot (Rose et al. 2019: 18).

Casali (2017) has presented some "norms" linguists may look for to more easily identify a language as having a /2IU/ system such as Guang languages. /2IU/ refers to a language having both /i/ and /u/, and /ɪ/ and /ʊ/. He notes that in such languages [+ATR] will likely be dominant and marked. He also describes common patterns of vowels that occur in /1IU/ vs. /2IU/ languages as diagnostics. I will discuss this further in Section 4.6 on [+ATR] dominance.

3.6 Summary of vowel inventory issues

In summary, this paper will assume each Guang language has a base of nine vowel phonemes, not including long or nasal vowel phonemes, and a [+ATR] allophone of /a/. We have seen historically there has been little consistency in vowel inventories across descriptions of Guang languages. Based on the acoustic and other evidence, patterns arise that suggest each of the languages has the same nine-vowel system. It may also be generally assumed that Guang languages have nine long vowel phonemes. We may assume that South Guang languages plus Nkonya and Nkami have up to nine nasal vowel phonemes. The issue here is whether linguists have found contrastive examples of these in their data, and it may still be the case that token nasal vowels do not occur contrastively in some of the languages for one reason or another.

4. ATR harmony

4.1 Overview of ATR harmony in Guang languages

ATR harmony may be the most pervasive vowel phenomenon in the Guang languages, and also one of the most studied. Casali (2002: 9) has described ATR harmony (for Nawuri) in the following way: "Within a morpheme containing only non-low vowels, all vowels will normally be drawn from the same [ATR] set" He specifies "non-low" because the low vowel [a] is neutral and can occur in both settings.

[+ATR] harmony in Guang languages is generally regressive, or anticipatory, spreading from vowels on the right and moving leftward. Sometimes it is blocked by a word or phrase

break, and sometimes by the low vowel [a]. [+ATR] generally spreads within a word, but may spread further to the end of the previous word, or to function words. It has been generalized that affixes harmonize with the root. This does not exactly hold as harmony is regressive, and does not often spread to suffixes, though sometimes spreads from suffixes, and will spread from roots to prefixes. While much about ATR harmony in Guang can be generalized for all the languages, there seem to be elements of the process that differ slightly from language to language.

4.2 ATR Harmony and affixes in Guang

Studying affixes in Guang languages is extremely helpful in understanding patterns of ATR harmony. Because [+ATR] spreading in Guang languages appears to be consistently left-spreading, it is of interest to note issues of suffixes especially and what happens to ATR values around them. There are several reasons to assume regressive [+ATR] spread in Guang languages. First, it has been noted by several Guang linguists (Casali 2002, Peacock 2007) that ATR harmony is primarily regressive. We will also see in instances of post-lexical harmony, left-spreading harmony is unbounded while right-spreading harmony is highly restricted. Finally, Hyman (2002) argues that anticipatory harmony is overall more common than preservative harmony. I will discuss directionality more in Section 4.5. Assuming root-controlled harmony, one would expect the ATR value of the suffix to align with that in the root. However, if we are assuming directional [+ATR] dominant harmony, it may be assumed that [+ATR] in the root does not spread rightward to the suffix. We would also not expect that a [-ATR] suffix would affect any change in the root since it is only [+ATR] that can spread. Does [+ATR] sometimes spread from the root to the suffix? Are there suffixes that spread [+ATR] to the root? This section will address these questions.

4.2.1 Prefixes

The behavior of prefixes regarding ATR harmony in Guang is on the whole predictable. Many authors would simply say they harmonize with the root. However, it would be more accurate to say, as [+ATR] spread is regressive, [+ATR] in the root will almost always spread to the prefix. There have not been any dominant [+ATR] prefixes noted. The following sets of examples show ATR harmony in Guang prefixes. The examples in (5) are paired according to prefix, and show the alternation with [-ATR] and [+ATR] roots. As all of these prefixes appear to 'harmonize' we would assume they are all underlyingly [-ATR] and become [+ATR] before a [+ATR] vowel in the root.

(5) Examples from Gua (Obiri-Yeboah and Rose 2017: 4)

a. [ɔ́-kpʊ́tɛ̀] 'separation'

b. [ó-sóbì] 'pulling'

c. [á-tʃì] 'woman'

d. [ą́-bì] 'child'

e. [ɛ́-tʃì] 'women'

f. [é-bì] 'children'

(6) Examples from Nkami (Akanlig-Pare & Asante 2016: 28)

a. [oɲi] 'mother'

b. [osi] 'waist'

c. [ɔsɪ] 'father'

d. [ɔdɪda] 'chin'

(7) Examples from Gichode (Lenwah 1979: 46-47)

a. [gè-kì] 'knife'

b. [gé-sí] 'year'

c. [gé-bɛ́] ‘palm tree’

d. [gè-dɔ́] ‘farm’

(8) Examples from Gonja (Nelson et al. 2016: 136)

a. [bìŋɛ́nʔ] ‘men’

b. [bìsípʊ̂] ‘cousins’

c. [bìtʃééʔ] ‘women’

d. [bìtéérí] ‘friends’

4.2.2 The diminutive suffix

Casali (2002: 28-29) states that it is arguable that Nawuri has a [+ATR] dominant suffix [ˉbi] which can cause [+ATR] to spread to the root. This suffix, which is the diminutive suffix, is addressed in several of the existing descriptions of Guang languages. The same [+ATR] spread from this suffix has been documented in Nkonya (Peacock 2007) and Nkami (Akanlig-Pare and Asante 2016).

(9) Examples from Nkami (Akanlig-Pare & Asante 2016: 37)

a. [ɔlɔ] → [olobi] ‘small pot’

b. [tılı] → [tilibi] ‘young goat’

c. [ɔblɔ] → [oblobi] ‘throat’

Interestingly, Nelson et al. (2016: 144-145) show the cognate diminutive suffix to not be dominant in Gonja. Instead it harmonizes with the root, occurring as [ˉbi] with a [+ATR] root and [ˉbı] with a [ˉATR] root.

(10) Examples from Gonja (Nelson et al. 2016: 144)

a. [kàbʊ̀bí] ‘kid’

b. [dʒɔ̀nʊ̀bí] ‘puppy’

c. [kòʃîbî] ‘chick’

d. [tʃùrùbî] ‘immature hippopotamus’

Painter’s description of Gua also seems to show the diminutive suffix /-bi/ causing the spread of [+ATR] into the root, though not further than a single syllable (1971: 245).

(11) Examples from Gua (Painter 1971: 245)

a. [è-dɛ̂] → [è-dè-bí] ‘thing’

b. [è-bɔ̂] → [è-bó-bí] ‘mountains’

c. [à-kpʊ́-kpʊ́] → [à-kpʊ́-kpú-bì] ‘farm mortar’

Obiri-Yeboah and Rose’s (2017) examples from Gua show that the harmony does spread through the root. They even give the same example as Painter, ‘thing’ (10a, 11a), showing the [+ATR] spreading through to the initial vowel.

(12) Examples from Gua (Obiri-Yeboah and Rose 2017: 4)

a. [ɛ̀dɛ̀] ‘thing’ → [èdè-bí] ‘small thing’

b. [ɔ̀bá] ‘hand’ → [bạ́-bí] ‘finger’

c. [átʃì] ‘sponge’ → [ạ́tʃì-bí] ‘small sponge’

Snider (1990b), and others (Obiri 2013, Akanlig-Pare & Asante 2016: 36) have described a cognate morpheme as a root which forms compounds. From the example given, this root /-dʒi/ does spread [+ATR] harmony through the compound word, if it is the second word in the compound.

(13) Example from Chumburung (Snider 1990b: 25)

[kà-bí] ‘mountain’ + [kí-dʒí] ‘seed’ → [kə̀-bí-dʒí] ‘hill’

Hansford also provides an example of this morpheme spreading [+ATR] in a compound.

(14) Example from Chumburung (Hansford 1990: 65)

[kì-sáá] + [-dʒí] → [kì-séé-dʒí] ‘insult’

Dundaa (2000) describes the same morpheme /dʒi/ in Krachi as sometimes spreading [+ATR] in fast speech. While he does not provide the counter examples, he notes other compound words which maintain different ATR values.

(15) Examples from Krachi (Dundaa 2000: 6)

a. /kɪsɛrɪ/ 'hand' → [kiseridʒi] 'finger'

b. /kɔjɪrɪ/ 'body → [kojiridʒi] 'skin of man'

Bramson (1981: 9) states that in Cherepong "non-verbal suffixes do not obey the Vowel Harmony rule." [˗bi] does not harmonize with the root or spread [+ATR] to the root.

(16) Examples from Cherepong (Bramson 1981: 9)

a. [ạ̀ɲímkṕɛ̀bí] 'old man'

b. [àtʃĭkṕɛ̀bí] 'old woman'

Obeng (2008) does not provide much description for this suffix, but it appears [˗bi] may also be [+ATR] but not dominant in Efutu. It is not clear that the suffix patterns the same way in Efutu as in other Guang languages. It appears it may be attached to a word meaning small, which Obeng has transcribed as [tʃɪtʃɪbi].

Plunkett (1991: 111) describes an interesting case in Foodo. He states that the diminutive suffix [˗bi] usually spreads [+ATR] to the stem, but it also spreads [+ATR] to the following noun-class suffix /˗lɪ/, which becomes [˗li]. Foodo is the only Guang language with noun-class suffixes. The following example shows this process in Foodo. [˗bi] spreads [+ATR] to the root as well as to the following suffix.

(17) Example from Foodo (Plunkett 1991: 110)

a. [kɔ̀fɛ́lʊ́ʊ́] 'moon' → [dìfélébílí] 'star'

From Lenwah's (1979) wordlist, as well as the comparative list included by Snider (1990b), one can find several words that employ this diminutive suffix in Gichode. I tried to analyze these to find a pattern of suffixes in Gichode in order to compare with other Guang languages. It appears that there are some inconsistencies or mistakes in the transcriptions. Lenwah's transcriptions also differ somewhat from Snider's. However, it may be argued based on these examples that [ˉbi] in Gichode spreads [+ATR] to the root. This process may be inconsistent or optional, and blocked by the low vowel, but there is evidence for it.

(18) Examples from Gichode showing [+ATR] spread (Lenwah 1979)

a. [nádí] 'cow' → [gènádébì] 'calf'

b. [gìkɔ̀ré] 'drum' → [ǹkòríbí] 'small drums'

(19) Examples of /a/ blocking [+ATR] spread (Lenwah 1979)

a. [gɛ̀lɛ̀ŋgá] 'gourd' → [gɛ̀lɛ̀ŋgábí] 'small gourd'

b. [gìbá] 'hand' → [gìbábí] 'finger'

Finally, a survey of Dogbe's wordlist of Dompo appears to show [bi] occurring as a separate word to indicate something small or a baby animal. It does not appear to affect the ATR value of the previous word (Dogbe 2018: 8-9).

There are some interesting variations with regards to this diminutive suffix in Guang, with as many as three different patterns. We see a dominant suffix which spreads [+ATR] and is invariable [+ATR], a suffix that harmonizes with the root, and a suffix that is invariable [+ATR] but does not spread [+ATR]. This can be seen in the chart in Section 4.7 below.

4.2.3 The agentive suffix

There is another suffix common across the Guang languages that operates differently from the diminutive suffix. This is the agentive suffix, which creates nouns from verbs. The initial consonant varies some but this suffix has a back/round vowel. We see two different

patterns with this suffix in Guang. In some languages it harmonizes with the root, in others it is invariably [-ATR]. In Nawuri this suffix is realized as either [-pu] or [-pʊ]. Dundaa (2000) also shows this suffix harmonizing in Krachi. Plunkett (2009: 133) states the agentive suffix in Foodo is /-wO/, the capital letter indicating that it is subject to vowel harmony, with allomorphs [-wo] and [-wɔ].

(20) Examples from Krachi (Dundaa 2000: 6)

a. [ɔkpɔmpʊ] 'hunter'

b. [ɔdɔ:pʊ] 'farmer'

c. [okisipu] 'fetish priest'

Casali (1995b: 29) provides a footnote that this same suffix occurs consistently as [-pʊ] in Chumburung. Peacock (2007), Nelson et al. (2016), and Akanlig-Pare and Asante (2016) also show the agentive suffix is invariable in Nkonya, Gonja, and Nkami ([-hʊ] in Nkami), respectively. Examples from Snider (1990b) of verbs becoming agentive show clearly how [+ATR] spreads leftward to the noun-class prefix, but does not spread rightward to the agentive suffix in Chumburung. The following example sets show this suffix in Chumburung, Gua, and Cherepong.

(21) Examples from Chumburung (Snider 1990b: 24)

a. [fé] 'to sell' [ò-fé-pʊ́] 'seller'

b. [lʊ́] 'to weave' [ɔ̀-lʊ́-pʊ́] 'weaver'

c. [tʃá] 'to heal' [ɔ̀-tʃá-pʊ́] 'healer'

d. [dʒì] 'to eat' [ó-dʒí-pʊ́] 'eater'

(22) Examples from Gua (Obiri-Yeboah & Rose 2017: 4)

a. [àdá-hʊ̀] 'master'

b. [abɔ̀ɔ́-hʊ̀] ‘messenger’

c. [əbíélì-hʊ̀] ‘blacksmith’

d. [əsítìí-hʊ̀] ‘deaf person’

(23) Examples from Cherepong (Bramson 1981: 9)

a. [ã̀ɲíntíhʊ̀] ‘pregnant woman’

b. [àwúdʒíhʊ̀] ‘murderer’

The different patterns of the diminutive and agentive suffixes in Guang are quite interesting. I will discuss this further in Sections 4.5 and 4.6 on directionality and [+ATR] dominance.

4.2.4 Other suffixes

Hansford (1990: 120) describes the ATR value of several suffixes in Chumburung as “invariable,” thus not changing with the root. Most, but not all, of these suffixes are [-ATR].[7] Snider (1990b) and Hansford (1990) do show one locative suffix or enclitic that appears to experience right-spreading [+ATR] harmony. They list the underlying form as something like /-lO/. The morpheme will surface several different ways depending on the consonants in the root as well as its ATR value. Examples (24) and (25) show the vowel of this morpheme alternating between [o] and [ɔ] depending on the ATR value in the root. Akanlig-Pare and Asante (2016: 37) have labeled a cognate morpheme in Nkami as a suffix, [-lɔ], glossed ‘inside.’ They have found only three instances where this morpheme receives progressive [+ATR] harmony. Elsewhere it remains [-ATR].

[7] From Hansford’s (1990: 164) work it appears there may be one [+ATR] suffix, which he groups with other suffixes as invariable. This is [-nji] which signifies a member of religious or ethnic group (e.g. /baasarı-nji/ ‘Bassari person’)

(24) Examples from Snider (1990b: 10)

a. [dʒono-ro] ‘in the dog’

b. [kəle-lo] ‘in the funeral’

c. [lɔn-nɔ] ‘in the compound’

d. [dun-no] ‘in the heart’

(25) Examples from Hansford (1990: 110-111)

a. [mʊ́-rɔ̀] ‘(in) him’

b. [ŋ̀jjíí-ròˈ] ‘(in) sticks’

c. [kìsán-lɔ̀] ‘in hand’

d. [pùn-ló] ‘in an instant’

(26) Examples from Akanlig-Pare and Asante (2016: 37)

a. /obu-lɔ/→ [obulo] ‘room’

b. /ntʃu-lɔ/ → [ntʃulo] ‘a source of water’

c. /eŋu-lɔ/ → [ŋulo] ‘inside the head’

d. /sukuu-lɔ/ → [sukuulɔ] ‘school compound’

e. /ewwi-lɔ/ → [eweilɔ] ‘inside the house’

Examples (26a-c) show the change and examples (26d, e) show no variation.

Plunkett (2009: 112, 117) claims that Foodo is the only one of the Guang languages that has both noun-class prefixes and suffixes. He states that most of these harmonize with the ATR value in the stem, noting at least one [‑ATR] suffix that does not harmonize with the root. Plunkett denotes affixes as unspecified, without an underlying ATR value.

(27) Harmonizing suffixes in Foodo (Plunkett 2009: 119)

a. /dI-sí:-lÍ/ → [dìsíílí] ‘horn’

b. /dI-dúŃ-lÍ/ → [dùdúńdí] ‘millet seed’

c. /dI-gbà-lÍ/ → [dígbálì] ‘market’

From the examples in this section we see that there are several different patterns for suffixes in Guang. These are the dominant [+ATR] suffix, those that are invariably [-ATR], those that harmonize which are likely underlyingly [-ATR], and the unusual case of a non-dominant [+ATR] suffix in Cherepong and possibly Efutu.

4.3 The Low Vowel and ATR harmony

The low vowel, /a/, in Guang languages has been a main point of interest, specifically in its relation to ATR harmony. As noted above most authors agree on the nine-vowel system of Guang languages, though they give different accounts of a possible [+ATR] allophone of /a/. This section will look at /a/ in Guang languages specifically in relation to ATR harmony issues, and will include some acoustic analysis of this phoneme.

4.3.1 /a/ is neutral

/a/ is neutral with regards to ATR harmony in Guang languages, meaning it occurs in both [+ATR] and [-ATR] environments. When /a/ occurs preceding [+ATR] vowels, it is likely to be phonetically a [+ATR] allophone such as [ạ], though this allophone may not occur in all Guang languages. The following are examples from Nkami showing /a/ in both [+ATR] and [-ATR] words.

(28) Examples from Nkami (Akanlig-Pare & Asante 2016: 30)

a. [kɪla] ‘count’

b. [dʒansɛ] ‘olden times’

c. [bisa] ‘ask’

d. [tasi] ‘aunt’

e. [tʃago] ‘rag’

Snider (1990b: 139) shows that /a/ will be realized phonetically as [+ATR] when it occurs in a word, to the left of a [+ATR] vowel. He uses [ɜ] to signify this allophone. We will see a variety of phonetic symbols have been used to indicate this [+ATR] allophone of /a/. In his discussion of proto-Guang root vowels, Snider (1990b: 111) summarizes that if the first vowel in a root is [+ATR], the second vowel must also be [+ATR] or be /a/. If the second vowel in a root is [+ATR] than the first vowel must also be [+ATR]. In this case the low vowel is realized as [ɜ]. According to Snider’s reconstruction, /a/ should operate this way in all Guang languages. He describes historical changes that have affected /a/ in some of the Guang languages, but these have not changed the neutrality of /a/ in ATR harmony. The following examples show the [+ATR] allophone of the low vowel in Chumburung.

(29) Examples from Chumburung (Snider 1990b: 140)

a. [kpɜɜsi] ‘rat’

b. [dʒɜndeʔ] ‘onion’

c. [kɜpini] ‘ring’

Casali provides a very similar description to Snider’s, but with [ą] as the symbol for the [+ATR] allophone of /a/. Obiri-Yeboah and Rose (2017: 2) use [ɜ] as Snider has. They note this sound is allophonic as there are no roots with only this vowel, and it cannot occur word-finally in roots. Nelson et al. (2016) describe a somewhat raised and fronted variant of /a/ before [+ATR] vowels in Gonja, for which they also use [ą] as a label. Ansah (2012 :115) states /a/ is “realized as [ə] before syllables with /i/ or /u/” in Larteh. Akanlig-Pare and Asante have described /a/ as neutral with regards to ATR harmony in Nkami, stating that it does not have a [+ATR] allophone, but can freely occur in both [+ATR] and [‑ATR] contexts (2016: 30). As noted

above, according to my measurements of Nkami data the language does employ this allophone, [ạ], in [+ATR] environments.

Regardless of the suggested allophone label, we will see that /a/ is neutral in Guang languages. The label [ạ] which Casali and others have used is probably the most clear and straightforward, and is what I will use in this section.

4.3.2 Is /a/ opaque to ATR harmony?

Along with this issue of neutrality is the question of whether or not /a/ is opaque with regards to ATR harmony, meaning does [a] block the spread of [+ATR]? Casali (1997: 11) notes that it appears that an opaque /a/ is the norm for Ghanaian languages. He describes [a] as opaque to right-spreading [+ATR] harmony, such as to a suffix, but transparent to left-spreading [+ATR] in Nawuri (2002: 10). Casali (2002: 21) argues that where /a/ appears to be transparent to [+ATR] spreading, it must also be [+ATR], as in the allophone [ạ].

(30) Examples from Casali (2002: 22)

a. [gu-bwạạɾuuʔ] ‘water yam’

b. [gə-nạạwuɾi] “Nawuri’

c. [o-dạạnobiisi] (type of yam)

d. [gi-tạạkuɾi] ‘anthill’

As this process actually involves /a/ becoming [+ATR], and [+ATR] continuing to spread beyond it, /a/ is not simply transparent, though it is neutral.

Snider (1990b) shows [+ATR] spreads through /a/ post-lexically. /a/ will change to its [+ATR] allophone. This harmony may spread further leftward as well, but only to high vowels.

(31) Example from Snider (1990b: 140)

a. /kɪŋa dʒono/ → [kiŋɜ dʒono] ‘slave’s dog’

Obiri-Yeboah and Rose (2017) have also used [ɜ] to signify the [+ATR] allophone of /a/ in Gua. They do not specifically state whether /a/ is opaque to [+ATR] spreading, but the following examples appear to show that it is not. The vowels in the possessive pronouns are variable depending on the ATR value of the noun, and these examples show [+ATR] spreading from [ɜ].

(32) Examples from Gua (Obiri-Yeboah & Rose 2017: 5)

a. [wʊ́ áwɔ́lì] 'your book'

b. [wú ɜ́bíè] 'your chair'

c. [mʊ́ ádɛ̀] 'his cutlass'

d. [mú ɜ́tébì] 'his/her animal'

Plunkett (2009) does not acknowledge any [+ATR] allophone of /a/ in Foodo. Whether it is there or not, he has some examples that appear to show /a/ as transparent to ATR harmony. In these examples the first morpheme is the subject pronoun and the second is the tense/aspect marker. Where this marker includes /a/ it does not block harmony from a [+ATR] root to the subject pronoun. According to Plunkett, these pronouns are variable according to ATR value. The following example pairs show the subject prefixes in [+ATR] and [-ATR] settings.

(33) Examples from Foodo (Plunkett 2009: 130-131)

a. [ɔ̀-máɲ́-náá] 'he did not go'

b. [ò-máŋ́-wù] 'he did not see'

c. [fíí-à-tɔ́lì] 'you(PL) fell'

d. [fíí-à-wù] 'you(PL) saw'

Though this process looks very similar, it is somewhat different from those we have seen above. As Plunkett is proposing that /a/ does not change as it allows [+ATR] to pass through it, this is a traditional instance of transparency.

There are examples from other Guang languages which are not consistent with the pattern of /a/ in Nawuri. Peacock states about Nkonya "+ATR spreading is blocked from spreading further leftward than a syllable containing /a/" (2007: 24). Akanlig-Pare and Asante (2016) also state that /a/ is opaque in Nkami. Example (34a) shows [+ATR] spread from the suffix, and example (34b) shows this spread being blocked by /a/. The examples in (35) show /a/ blocking [+ATR] spread in Nkami.

(34) Examples from Nkonya (Peacock 2007: 24)

a. /ɔ̀-tʊ̀-bíʔ/ → [ɔ̀tʊ̀bíʔ] 'spoon'

b. /ɔ̀-kpà-bí/ → [ɔ̀kpàbí] 'forked stick'

(35) Examples from Nkami (Akanlig-Pare & Asante 2016: 33)

a. [bɛ-ma-ʧu] 'they will not lift'

b. [anɪ-ma-ʤi] 'we will not eat'

Ansah (2012: 115) states that /a/ is opaque in Larteh, though before a [+ATR] vowel it will be realized as [ə]. She does not provide clear examples of this.

Both Painter (1970) and Nelson et al. (2016) acknowledge a [+ATR] allophone of /a/, but it is not clear whether this allows the spread of [+ATR] through it.

It appears that there may be as many as three different patterns with /a/ and ATR harmony in Guang. /a/ is opaque to ATR harmony in Nkonya, Nkami, and Larteh. In Nawuri, Chumburung, Gua and others [+ATR] will change [a] to [ạ] and may spread beyond the low vowel. Based on Painter (1970) and Nelson et al. (2016) it is not clear if the allophone of /a/ in

Gonja allows [+ATR] to pass through or not. I will discuss this further in the following section. /a/ is transparent in Foodo. However, as noted, it is possible that the [+ATR] allophone does exist in Foodo, in which case it would align with the same pattern as Chumburung and Nawuri.

4.3.3 The low vowel in Gonja

Neither Painter (1970) nor Nelson et al. (2016) stated definitively whether /a/ is opaque to ATR harmony in Gonja. Nelson et al. acknowledge a [+ATR] allophone of /a/ but I could not find any examples showing [+ATR] spreading beyond /a/. I analyzed some recordings of a Gonja speaker[8] in order to attempt to answer this question. These recordings were collected by Casali in 2015. The recordings I analyzed are of words in habitual tense. Each begins with a 2SG subject marker /fɪ-/ followed by the habitual marker /kaa-/, and then the verb root. From other occurrences, we know the person marker is subject to ATR harmony, surfacing as [fɪ] or [fi]. I made preliminary measurements of the vowel in the subject marker to evaluate if [kaa-] would allow [+ATR] to pass through. The results may provide some insight into this question.

Again, the main correlate of [+ATR] is F1. From my measurements for /fɪ-/ prefix vowels in [+ATR] settings, that is preceding /kaa-/, I found a range of 347-414 Hz for F1. For the vowels in [-ATR] settings the F1 values ranged from 373-504 Hz. These ranges do overlap, still it appears that /a/ does allow [+ATR] to pass through, at least at some level, in Gonja. I was able to conduct measurements on the same set of words from the same speaker without the habitual marker. In this context, the subject marker surfaces as [fɪ] or [fi] depending on the ATR value of the vowels in the root. From these examples the range I found for [i] is 279-375 Hz. The range I found for [ɪ] is 333-540 Hz. Table 3 shows the average F1 values I found for each vowel in both sets of data.

[8] I am grateful to Mr. Amidu Changa (name used with permission), who pronounced the examples in these recordings.

Table 3 F1 values for Gonja prefixes

	Habitual Examples [fVV-kaa-ROOT]	Progressive Examples [fVV-ROOT]
[+ATR] context ([ii])	382 Hz	328 Hz
[-ATR] context ([ɪɪ])	430 Hz	465 Hz

This table shows that, on average, [i] has a slightly lower F1 before a [+ATR] vowel than it has before /a/, or [ạ]. [ɪ] has a slightly higher F1 average in this scenario. Between the average values and the ranges found, I think this acoustic evidence can confirm that /a/ does allow [+ATR] to pass through to the proceeding prefix. It seems that the presence of the low vowel may have some effect on the F1 value of the preceding vowel as these values are slightly higher than the average.

Figure 6 charts the F1 and F2 measurements of the vowels from the subject markers in this Gonja data set

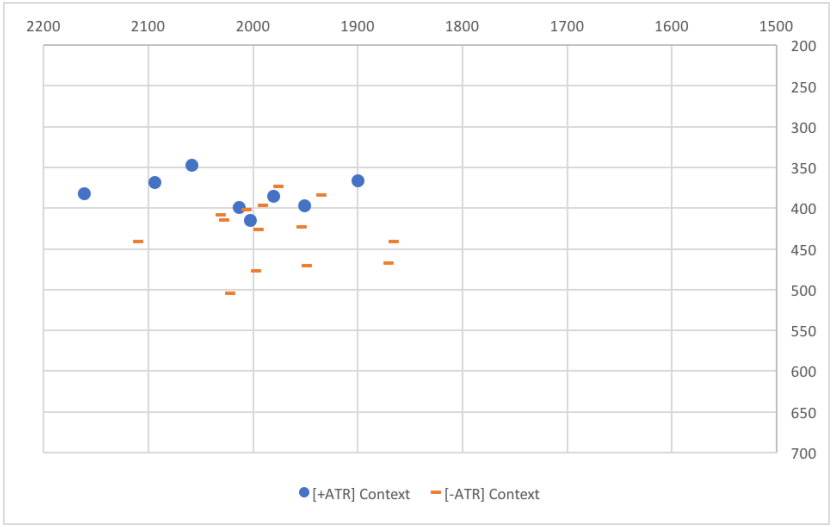

Figure 6 Scatter plot of formant values for [ii] and [ɪɪ]

I did measure the [aa] vowels in the habitual markers in these examples to confirm that the [+ATR] allophone was present in [+ATR] settings. The results from the measurements of [aa] were much clearer. When the F1 values were ordered from lowest to highest there was

almost no overlap, almost all of the [aa] in [+ATR] contexts measured with lower F1 values than those in [-ATR] contexts. The range in these examples for the F1 of [ạạ] is 496-773 Hz. The range from these examples for [aa] in [-ATR] contexts is 762-858 Hz. We also find that the F2 values for /aa/ in [+ATR] contexts average higher than those in [-ATR] contexts. These higher F2 values indicated fronting.

While this is a fairly small data set, and some overlap with the measurements of the subject marker, there still seems to be an emergent pattern of the subject markers in [+ATR] words measuring with lower F1 values. Based on these results and patterns from other Guang languages I think it may be assumed that /a/ is not opaque to ATR harmony in Gonja. This again raises some questions about Nkonya and Nkami. Peacock (2007) notes the presence of the allophone [ạ] in Nkonya, but states that /a/ is opaque to [+ATR] spread. Akanlig-Pare and Asante (2016) don't recognize this allophone, but also believe /a/ to be opaque. It would be interesting to conduct some acoustic study to further analyze this issue in Nkonya and Nkami.

4.4 Post-lexical ATR spread

Some level of post-lexical [+ATR] spread is fairly common in Guang languages. This is interesting as harmony processes are most often discussed on the lexical level. In post-lexical ATR harmony in Guang we find [+ATR] spread in both directions, though rightward spread is fairly restricted. There is also variety between Guang languages as to how restricted or unrestricted post-lexical [+ATR] spread may be. Snider and Casali have found leftward post-lexical spread in Chumburung and Nawuri is unbounded, at least in casual speech. Post-lexical ATR harmony has not been consistently described in treatments of Guang languages, only a few linguists have noted it.

Snider, Casali, and Obeng have all described processes of post-lexical ATR harmony. Snider describes this harmony process as "unbounded and gradient unless blocked by a low

vowel." (1990b: 140). Beyond the first vowel to the left of the [+ATR] vowel, [+ATR] will only spread to high [-ATR] vowels.

(36) Examples from Chumburung (Snider 1990b: 140)

a. /fʊrɪ keri/ → [furi keri] 'deer's side'

b. /ɪbʊrɪ kudu/ → [iburu kudu] 'ten voices'

c. /ɔlʊpʊ dʒepu/ → [ɔlupu dʒepu] 'weaver's tongue'

d. /ɔfa:sɛ keri/ → [ɔfa:se keri] 'leopard's side'

Examples (36c, d) show the post-lexical harmony being blocked by non-high vowels.

In Nawuri left-spreading [+ATR] is not very restricted post-lexically, and can spread through more than one word.

(37) Examples from Nawuri (Casali 1995b: 65)

a. /ɪpʊ lembiri/ → [ipu lembiri] 'black soup'

b. /ɔtʊ: ginsi kɪ: mʊ/ → [otu: ginsi kɪ: mʊ] 'when he looked around'

c. /ɔsʊ gɪtɔ ju:risa/ → [osu gito ju:risa] 'he has something which is stolen'

d. /ɪsɪ ɪbʊ obuto/ → [isi ibu obuto] 'sand is in the room'

e. /kɔ:lɪ ji/ → [ko:li ji] 'take and eat'

These examples are interesting, showing how far [+ATR] can spread unrestricted. Casali notes this process is optional and will likely only occur in fast or casual speech. The effect may be gradient further from the original [+ATR] vowel. The vowels /ɛ/, /ɔ/, and /a/ are less likely to accept [+ATR] spread than high [-ATR] vowels in this process (Casali 1995b: 66-67).

The post-lexical [+ATR] spread in Gua, described by Obeng (1995), is much more restricted than the process in Chumburung and Nawuri. [+ATR] will often spread to the final syllable of a preceding word, but not further.

(38) Examples from Gua (Obeng 1995: 149)

a. /kwamɪ dʒi/ → [kwami dʒi] ‘Kwame eats’

b. /dansʊ dʒi/ → [dansu dʒi] ‘Danso eats’

c. /ɔsɛkɪrɛ dʒi/ → [ɔsɛkɪre dʒi] ‘ɔsɛkrɛ eats’

While [+ATR] spread is primarily regressive, as we have seen, it may spread rightwards in certain situations. In Casali’s (1995b: 68-69) data from Nawuri, this spread only moves a single syllable to the right and only spreads to high [-ATR] vowels. Casali also says this process is optional and may be gradient. Snider (1990b: 140) shows the same, that rightward spread of [+ATR] is only post-lexical, only to one syllable and only to a high vowel.

(39) Examples from Nawuri (Casali 2002: 25).

a. /a-fuu fʊʊtɪ-sa/ → [ą̣fuufuutɪsa] ‘air for breathing’

b. /gi-buu tʊʊ-sa/ → [gibuutuusa] ‘a stone for throwing’

(40) Examples from Chumburung (Snider 1990b: 140)

a. /dʒono wʊrɪ/ → [dʒono wurɪ] ‘dog’s skin’

b. /dʒono wɛʔ/ → [dʒono wɛʔ] ‘dog’s mucus’

c. /kofi kɪbaŋ/ → [kofi kibaŋ] ‘Kofi’s paddle’

d. /kofi bɔtɪ/ → [kofi bɔtɪ] ‘Kofi’s sack’

Snider (1990b: 140) notes in conjunction with these examples, “ATR vowels never become non-ATR.” Again, these instances of post-lexical [+ATR] spread confirm [+ATR] dominance in Guang. We see that [+ATR] can spread both directions in certain settings, but [-ATR] never spreads. The directionality of ATR harmony in Guang is also affirmed here as we see how unbounded leftward spread may be, and instances of rightward spread are still quite restricted.

4.5 Directionality

Bakovic (2003) has presented a typology for harmony systems. His argument is centered on "root-outward" harmony. He emphasizes the idea of "stem identity," essentially that a stem may not be altered by the addition of an affix. He summarizes the analyses of directionality and underspecification, and generally argues against these. Bakovic seems to consider directionality simply as a consequence of a language's system of either prefixing or suffixing, giving examples from Tangale, a language with no prefixes, and Yoruba, a language with no suffixes. To account for "bi-directionality" in languages with both prefixes and suffixes some have proposed underspecification, essentially root vowels are specified for an ATR value, but affix vowels are not. Plunkett (1991: 39) offers this as a possible explanation for ATR harmony in Foodo. Bakovic argues against this theory as there is seemingly no reason why certain vowels would be specified and not others, and it always requires additional explanations (2003: 22).

Bakovic's description of "root-outward" harmony is that the feature value, in this case ATR, is invariable in the root and moves outward, it is not directional. It may be blocked. He presents "stem identity" as the most simple, unified description that can account for various differences language to language in the process of root-outward harmony. He finds other descriptions need to rely on a combination of directionality and underspecification to account for harmony processes.

The harmony processes in Guang languages seemingly do not fit into this framework Bakovic has developed, as it does not really allow for directional systems. The main indicator of this, as Casali has noted, is the presence of dominant suffixes, and their ability to cause change in the root. This affirms the idea that Guang ATR harmony is directional, specifically regressive. Bakovic's framework is based on the idea that the feature value in the root is never altered. Several Guang languages exhibit dominant suffixes which are capable of spreading [+ATR] to

the root. We have seen post-lexical [+ATR] harmony, which is predominantly left-spreading, is also capable of changing ATR values in the root in Guang languages. Lexical progressive [+ATR] spread to suffixes is rare. While Bakovic presents a clear argument in an attempt to unify harmony systems, directional Guang harmony systems do not fit with this analysis.[9]

4.6 [+ATR] dominance

In contrast to Bakovic (2003), I will argue that Guang languages exhibit [+ATR] dominance, which greatly informs their harmony processes. [+ATR] dominance refers to how [+ATR] operates in the language. [+ATR] will be preserved in processes such as hiatus resolution, also in vowel harmony [+ATR] spreads, while [-ATR] does not. This section will present what has been said on this issue and point to the conclusion that [+ATR] is dominant in Guang languages.

Snider (1990b) does not directly address the issue of dominance in his work. He does discuss ATR harmony in terms of the privative feature [ATR], signifying [ATR] or [+ATR] as the spreading value. Casali (2002) states definitively that in Nawuri, [+ATR] is dominant, and that its ATR harmony is not simply root-controlled, even though root-control has been seen as the norm for many African languages. His reasons for this conclusion are that only [+ATR] spreads, and that it is preserved in vowel coalescence (2002: 23). He shows that underlying [-ATR] vowels assimilate to [+ATR], but not the other way around (2002: 24). [+ATR] even spreads across word boundaries. In his list of West African languages with dominant [+ATR] systems he includes, Chumburung, Foodo, Gichode, and Krachi (2002: 29-30).

These findings have been echoed in many descriptions of Guang languages:

[9] Bakovic (2000) does acknowledge [+ATR] dominant systems.

1. Akanlig-Pare and Asante (2016: 35) describe Nkami as having a [+ATR] dominant harmony system, noting that only the [+ATR] feature can spread to [-ATR]. They note that since [-ATR] never spreads leftward it must be the "recessive feature."
2. Peacock (2007) gives examples of ATR harmony in agentive constructions, which are formed with the [-ATR] suffix /-pʊ/. In these words, the noun-class prefix will change with a [+ATR] root but the suffix will be invariably [-ATR].
3. Obeng (1995: 147, 150) shows how [+ATR] assimilation occurs from right to left in Gua, even across word boundaries. He states that the vowel quality of the root affects that of the prefixes, but also that it is only [+ATR] vowels which can cause assimilation.
4. Obeng (2008: 5) describes how roots in Efutu will either have all [+ATR] or all [-ATR] vowels (he includes [æ] as a [+ATR] phoneme). He notes that, for example, a [-ATR] prefix will assimilate to a [+ATR] root, but states clearly that a [+ATR] vowel will never assimilate to a [-ATR] vowel.

The evidence we have seen in the patterns of affixes in Guang also strongly suggests [+ATR] dominance. Casali (2002) has emphasized the presence of dominant [+ATR] suffixes in a language to be a strong indicator of [+ATR] dominance. The diminutive suffix [-bi] is [+ATR] and dominant in several Guang languages. The agentive suffix is [-ATR] and never dominant, never spreading [-ATR]. In the case of Nawuri and Foodo, the suffix gets its ATR value from the root. Elsewhere, the suffix is invariable, which gives evidence for the directionality of [+ATR] harmony.

Hiatus resolution in Guang also shows the dominance of [+ATR]. I will look at hiatus resolution in much more depth in Section 5, but in most cases of hiatus resolution, except for certain cases of vowel elision, [+ATR] will be preserved.

Casali (2017) has grouped languages such as the Guang languages under the label /2IU/ languages, meaning they have two high front and two high back vowels. Along with [+ATR] dominance, Casali believes these languages are characterized by showing positional neutralization against [+ATR]. He notes that [+ATR] vowels are mostly excluded from certain categories of function words including independent pronouns, demonstratives, determiners, and even affixes. We can see this in Guang affixes. Apart from the dominant [+ATR] suffix, most of the other attested affixes are underlyingly [-ATR]. There is also no evidence of dominant [+ATR] prefixes in Guang languages. These distinctions again show [+ATR] vowels to be marked and dominant in /2IU/ languages like the Guang languages.

Based on Casali's argument, it can be generally agreed upon that all Guang languages exhibit asymmetric, [+ATR] dominant harmony. This can be seen in the various descriptions of Guang languages through the way that [+ATR] spreads and is preserved. We will see further evidence of [+ATR] preservation in Section 5 on vowel coalescence.

4.7 Summary

It is clear that some broad generalizations can be applied to ATR harmony in Guang. [+ATR] is the only value that may spread; [+ATR] is dominant. Spread is generally regressive, it is only progressive in certain instances. There are some variations between Guang languages which can be seen in the following table.

Table 4 Comparing features of Guang languages

	/a/	Prefixes harmonize	Diminutive Suffix	Agentive Suffix	Other suffixes
Foodo	Transparent	Yes	Dominant (spreads [+ATR] right and left)	Harmonize w/ root	Most harmonize w/ root
Gonja	Assimilates and spreads [+ATR]	Yes, except one	Harmonize w/ root	Invariably [-ATR]	
Chumburung	Assimilates and spreads [+ATR]		Dominant	Invariably [-ATR]	
Krachi			Sometimes spreads [+ATR]	Harmonize w/ root	
Nawuri	Assimilates and spreads [+ATR]		Dominant	Harmonize w/ root	
Gichode		Yes	Dominant		
Nkonya	Opaque	Yes	Dominant	Invariably [-ATR]	
Nkami	Opaque		Dominant	Invariably [-ATR]	
Gua	Assimilates and spreads [+ATR]	Yes	Dominant	Invariably [-ATR]	
Efutu	Assimilates and spreads [+ATR]	Yes	Not dominant		Harmonize w/ root
Larteh	Opaque				
Cherepong			Not dominant	Invariably [-ATR]	

Despite some variations between languages in relation to ATR harmony, it is still clear that Guang languages exhibit regressive [+ATR] spread. [+ATR] vowels are marked and [+ATR] is the dominant value.

5. Rounding Harmony

5.1 Typology of rounding harmony

5.1.1 Is it harmony?

First, it should be noted that linguists vary on what is and what is not vowel harmony. Guang rounding harmony might not appear to all to actually be a harmony process. Stephen Anderson (1980) has tried to develop a clear definition for harmony which will distinguish it from other processes such as standard assimilation. In his discussion he notes that it is difficult to summarize specific criteria into a clear definition of harmony. He lists previous criteria from Clements: phonetic motivatedness, root-control, bidirectionality, unboundedness, and non-optionality. Anderson himself does not find all of these aspects necessary to indicate harmony, noting many harmony systems do not include all of these. Guang rounding harmony does not meet all of these criteria. Anderson then looks at the "mechanism" of vowel harmony. He notes that harmony processes are different from assimilation, as harmony should occur simultaneously across a domain, while assimilation is local and occurs a step at a time (1980: 13). He presents both spreading and prosodic assignment as possible mechanisms of harmony, eventually landing on prosodic assignment as the best way to categorize harmony. He includes an argument to discount spreading as the mechanism. Spreading is how many have described rounding harmony and [+ATR] harmony in Guang. This paper will take the view that rounding spread in Guang is a harmony process.

5.1.2 Categorizing round harmony systems

Guang round harmony has some interesting elements to add to the general typology of rounding harmony. The language family that is most notable for rounding harmony is the Altaic family. Abigail Kaun (1995) has written an extensive work on rounding harmony including an overview of rounding harmony throughout the Altaic language. She proposes a typology of rounding harmony, including nine different rounding harmony systems a language may have.

She did include information from Casali (1995a) on rounding harmony in Nawuri, and grouped Nawuri into this typology. She groups it with languages in which the target of rounding harmony must be a high vowel (Kaun 1995: 69). However, her discussion doesn't seem to align perfectly with the descriptions of rounding harmony in Guang. Many of her different types are based on constraints of vowel height, as in which vowel height can be a rounding harmony trigger and which can be a target in a given type. There is not very much discussion about vowel height in descriptions of Guang rounding harmony. It seems that many of the target vowels are high, but not all. For most Guang languages, it seems that a round vowel of any height may trigger round spread. Kaun's work also almost exclusively discusses progressive rounding harmony. Most round harmony in Guang is regressive. It seems a broader typology of rounding harmony may be required to include Guang languages.

Hulst and Weijer (1995: 523) have noted that rounding harmony often occurs in conjunction with another type of harmony, and the rounding harmony is more restricted than the other type. This is clearly the case in Guang with [+ATR] harmony being primary and round harmony being secondary.

5.1.2 Is the feature [round] privative?

Another issue relating to the typology of rounding harmony is whether [round] is a privative or binary feature. A full examination of this issue will be beyond the scope of this paper, but it is worth mentioning. Kaun (1995) doesn't specifically address this issue but she appears to discuss [round] as privative. Snider (1990b) seems to discuss [round] as a privative feature, while several other descriptions of Guang maintain a binary approach and speak of both [+round] and [‑round].

Hulst and Weijer (1995) discuss this issue in their typology of vowel harmony. They note that there seem to be no instances of [‑round] harmony. They argue that all of the features for

which vowels harmonize could be categorized as privative, or unary, and those that appear to be binary, such as [+/- ATR], are really pairs of unary features (e.g. [ATR] and [RTR]) (1995: 505). Hyman (2002) has cited Hulst and Weijer and also points to [round] being a privative feature.

Plunkett (1991: 36) diverges from this view. Using Goldsmith's auto-segmental approach, he states that [low] is privative, but that [round] must be binary to distinguish front vowels from back vowels and to show how /a/ has no value for round.

It appears that there is more of a consensus around the idea that [round] is a privative feature. This seems even clearer in the discussion of rounding harmony, as it seems we should never expect to see instances of [-round] spread. This paper will treat [round] as a privative feature.

5.2 Rounding harmony in Guang

This section will provide an overview of how rounding harmony has been described in Guang. Sub-sections are grouped by the different patterns of rounding harmony that have been described.

5.2.1 Noun-class prefixes

Many instances of rounding harmony in Guang involve round spread to prefixes. Snider (1990b: 215-239) describes the noun-class prefixes of Proto-Guang and the changes these have gone through to get to their present forms. From this analysis, it appears that every Guang language has noun-class prefixes which are subject to rounding harmony. Snider (1990b: 217) states that in Chumburung "all vowels (except a) which occur to the left of w or a round/back vowel, will be likewise round/back." The domain of rounding harmony is the phonological word, and /a/ is opaque to rounding harmony. Snider seems to only reference rounding harmony in relation to nouns, specifically noun-class prefixes. He provides examples with the noun-class

prefix /kI⁻/. Examples (41c, d) show this prefix receiving rounding harmony and the examples in set (42) show /a/ blocking the spread of rounding harmony.

(41) Examples from Chumburung (Snider 1990b: 23)

a. [kìdʒàŋŋí] ‘meeting’

b. [kìkíŋŋí] ‘returning’

c. [kʊ̀lɔ́] ‘sickness’

d. [kùsúŋ] ‘work’

(42) Examples of opaque /a/ (Snider 1990b:138)

a. [kɪkatɔ] ‘eye’

b. [kɪdabɔŋ] ‘cheek’

c. [kɪjafɔrɪ] ‘young man’

Hansford (1990) provides examples of the prefix which he glosses /kV⁻/, as if the features of the vowel are unspecified.

(43) Examples from Chumburung (Hansford 1990: 62)

a. /kí-bíí/ ‘a time’

b. /kʊ̀-wɔ́/ ‘snake’

c. /kì-jéé/ ‘meat’

d. /kù-ŋú/ ‘head’

Casali (1995a) gives a very specific rule for rounding harmony in Nawuri, showing that labial spread is right-to-left, from a vowel to a high vowel. This gives a very restricted picture of rounding harmony. Casali has recorded rounding harmony spread to only one morpheme in Nawuri, a noun-class marker /gI/. Here ‘I’ just represents a high vowel (Casali 1995a: 651). This marker will be realized with a round vowel if the root begins with a [w] or labialized consonant,

or if the first vowel of the root is round. This process is obligatory. However, if a labial consonant, such as [p] or [b], occurs between /gI/ and a round vowel in the root, it blocks rounding harmony, though rounding in the prefix may still occur optionally in fast speech (1995b: 57-61). Snider (2018: 102) has also noted this blocking phenomenon in Chumburung, but states that it is optional.

102).

(44) Examples of rounding harmony in Nawuri (Casali 1995b: 57)

a. [giɲi] ‘tooth’

b. [gɪba:ʔ] ‘ hand’

c. [gʊsʊ] ‘ear’

d. [gujo] ‘yam’

e. [gʊwɛ:ʔ] ‘sympathy’

(45) Examples of round spread being blocked in Nawuri (Casali 1995a: 652)

a. [gimu] ‘heat’

b. [gipula] ‘burial’

c. [gibootoo] ‘leprosy’

We see ATR harmony applies here as well. Though this process only seems to affect one noun-class marker, Casali argues that this is the only context in Nawuri with the necessary conditions to trigger rounding harmony. He provides other examples to show how constraints elsewhere in the language would prevent rounding harmony from applying to other morphemes (1995b: 59-60).

Nelson et al. (2016) have pinpointed at least three prefixes, again noun-class markers, which are subject to rounding harmony in Gonja. These are /kI-/, /bI-/, /ka-/. The following are

examples showing the various realizations of these prefixes, due to both ATR and rounding harmony.

(46) Examples of /kI⁻/ in Gonja (Nelson et al. 2016: 135)

a. [kí-bɛ́] ‘market’

b. [kí-ɲí] ‘tooth’

c. [kù-mú] ‘head’

d. [kʊ̀-pʊ̀] ‘forest’

Here /kI⁻/ is cognate with /gI⁻/ in Nawuri and /kV⁻/ in Chumburung, and operates similarly except that /kI⁻/ will experience rounding harmony even in the case of an intervening labial consonant.

(47) Examples of /bI⁻/ in Gonja (Nelson et al. 2016: 136-137)

a. [bì-sípʊ̂] ‘cousins’

b. [bì-téérí] ‘friends’

c. [bʊ̀-wʊ́pâ] ‘mother’s brother’

d. [bú-wúɾâ] ‘chief’

e. [bí-tùtò] ‘father

f. [bì-tɔ́ɔ́mâ] ‘namesake’

The authors note that round spreading to /bI⁻/ is not consistent, and provide some exceptions (47e, f). They have not delved fully into this issue, but note that the prefix is somewhat more likely to be realized with a round vowel if followed by a labial or velar consonant, and less likely if followed by a coronal consonant.

(48) Examples of /ka⁻/ in Gonja (Nelson et al. 2016: 137-138)

a. [ká-dí] ‘town’

b. [kạ́-kúlʔ] ‘heap’

c. [kà-bɔ́ɔ́ʔ] ‘messenger’

d. [kó-dúúʔ] ‘tail’

e. [kò-wúɾóóʔ] ‘hat’

f. [kɔ́-nɔ́] ‘mouth’

The case of /ka⁻/ is quite unusual compared to the other examples we have seen. For one, this is the first example we have encountered of round spreading to a [⁻high] vowel. Examples (48a-c) show the standard realizations for this prefix. Example (48f) is the only example provided by Nelson et al. that surfaces as [kɔ-] for this prefix. Examples (48d-f) show rounding harmony spread to /a/, which is interesting as we do not see many examples of this in Guang. The authors speculate that words with this prefix which show rounding harmony may have higher frequency. They also note that it is not very unusual for [e] and [o] to alternate harmonically with [a] in nine-vowel languages (2016: 137-138). Snider (1990b: 224) observed rounding for this prefix in Krachi, Gichode, Nawuri, and Nkonya along with Gonja.

Plunkett has also described rounding harmony in Foodo nouns. He states (2009: 112) that it is “more restrictive than ATR harmony and often varies among speakers.” He has identified three noun-class prefixes which experience rounding harmony: /dI-, /bI⁻/, and /kU⁻/. It is worth noting that Plunkett may be the only one who has noted issues of trigger height for rounding harmony in Guang. As the rounding is variable in Foodo, Plunkett notes that rounding is more likely when the trigger is a high round vowel and less likely when the trigger is mid round vowel or a /w/.

Rounding in Foodo spreads most consistently to the prefix /dI⁻/, though still not 100% of the time. Plunkett states that for this noun-class pattern, stems with /a/ will always have a non-round prefix (1991: 42).

(49) Examples from Foodo of prefix /dI⁻/ (Plunkett 2009: 119, 121)

a. [dìsíílí] ‘horn’

b. [dʊ̀kɔ́lí] ‘debt’

c. [dùdúńdí] ‘millet seed’

d. [díɲɔ́wɔ́lí] ‘breast’

Plunkett notes that rounding of the prefix /⁻bI⁻/ is almost always optional, giving only two examples where it is required. Example (50c) shows that [+round] may also spread from [w].

(50) Examples from Foodo of prefix /bI⁻/ (Plunkett 2009: 128, 134; 1991: 44)

a. [bìdáá] ‘hitting’

b. [bʊ́tɔ́ɔ̀] or [bítɔ́ɔ́] ‘paying’

c. [bʊ̀wɛ́ɛ̀] or [bìwɛ́ɛ̀] ‘chewing’

d. [bùbúséé] ‘repeating’

e. [bʊ̀lɔ́ɔ́] ‘weaving’

Plunkett has included the prefix /kU⁻/ in this discussion, stating that some speakers will pronounce this with a non-round vowel if the first vowel of the stem is non-round. Based on what Hulst and Weijer have said, we do not ever expect to see spread of [⁻round]. Plunkett does note that it is possible that the underlying form of this prefix is in fact /kI⁻/, noting that there would be exceptions on both sides, and he believes there are fewer exceptions for /kU⁻/ (1991:

40). He also mentions the possibility that there are two separate prefixes, /kʊ⁻/ and /kɪ⁻/, though he thinks this is unlikely. This phenomenon seems complicated and there are not enough examples to sort it out clearly. Plunkett admits to not having investigated the issue thoroughly. Another consideration is that Foodo noun prefixes are paired with suffixes. Plunkett depicts this noun-class agreement pattern as /kU-root-U/. It is possible the suffix /⁻U/ is contributing to these issues and making it more difficult to decipher, as other Guang languages do not have such suffixes.

(51) Examples of Foodo prefix /kV⁻/, always [round] (Plunkett 1991: 41; 2009: 113)

a. [kʊ̀pí:ʊ́] ‘forest’

b. [kʊ̀fɛ́lʊ́:] ‘moon’

c. [kʊ̀jɛ́ʊ̀] ‘cheek’

(52) Examples of Foodo prefix /kV⁻/, sometimes [round] (Plunkett 1991: 41; 2009: 119)

a. [kítʃɛ́ʊ́] or [kʊ́tʃɛ́ʊ́] ‘rainy season’

b. [kʊ́tííʊ̀] or [kítííʊ̀] ‘goat’

c. [kítâŋ] or [kʊ́tâŋ] ‘placenta’

(53) Foodo prefix /kV⁻/, never [round] (Plunkett 1991: 41)

a. [kítá:ʊ̀] ‘cloth’

b. [kítâŋ] ‘forgetfulness’

Plunkett notes that examples (52c) and (53b) are the same, but only (52c) may be pronounced with a [round] vowel by some speakers and with a non-round vowel by others. According to Plunkett, (53b) is never pronounced with a round vowel. Interestingly, one example, (51c) ‘cheek,’ which Plunkett listed as always round in his 1991 work, is transcribed with a non-round

suffix vowel in his 2009 work. This may indicate that this process is even more variable by speaker.

5.2.2 Person and possessive markers

Though noun-class markers are the most common recipients of rounding harmony in Guang, there are other morphological elements which may receive round spread. Obeng (2008) and Agyeman (2016) have both described round spread to subject and possessive markers in Efutu. Their accounts agree overall. Obeng adds that rounding harmony affects tense/aspect markers though he provides no examples of this. The following examples from Agyeman show rounding spread to possessive markers in Efutu.

(54) Examples from Efutu (Agyeman 2016: 77)

a. [mú-kúr̀] ‘my husband’

b. [mʊ́-ŋ̀kɔ́tɔ́w] ‘my crabs’

c. [mí-sê] ‘my father’

d. [mí-ɲàmá] ‘my boat’

These examples show four different realizations of this possessive marker based on ATR and rounding harmony. The way this process has been described by Agyeman is that either [+round] or [‑round] can spread from the root to these prefixes. She then makes an odd statement, saying that certain prefixes resist [‑round] spread and others resist [+round] spread (2016: 77). This does not align with harmony patterns we have seen. Again, we would not expect [‑round], or non-round, to spread. It would likely be better to say the subject and possessive agreement markers for 1SG (/mi‑/), and 1 and 2PL (/anɪ‑/) are subject to rounding harmony, as they are underlyingly not round. The pronouns which are not affected by rounding harmony are the 2SG, 3SG, 3PL, and inanimate SG/PL. These are /ɔ‑/, /mʊ‑/, /amʊ‑/, and /ɪ‑/ respectively (2016:

135). Other than the SG/PL inanimate pronoun, /ɪ-/, all of these are underlyingly round. There are likely other constraints that would prevent /ɪ-/ from becoming round. Casali (1995a: 655) describes what may be a cognate prefix in Nawuri, [i] or [ɪ], and states this does not become round, as it maintains its [-back] feature. Many vowels in Guang become centralized between consonants. Casali has stated that only centralized vowels can become round. The vowel in /gI-/ or /kI-/ will always be interconsonantal, and therefore become centralized, and [+back], and can then be rounded. The marker /ɪ-/ will retain its [front] value, and therefore cannot become rounded according to Casali.

Obeng (2008: 5) states simply that "vowels in verbal and nominal affixes may agree in +/-Round harmony with those of the verb or noun root."

(55) Examples from Efutu (Obeng 2008: 6, 35)

a. [mɔ̀dɔ́] 'I liked'

b. [mìnì] 'I know'

c. [mùú ŋwê] 'I'm full'

d. [mìí sínà:sé] 'I sit down'

e. [mɪɪba] 'I come'

In terms of ATR and rounding harmony, these examples are as expected. Example (55c) appears to show that a labialized consonant can spread [round] to the prefix vowel in Efutu.

5.2.3 Tense-aspect markers

Another environment in which we see rounding harmony in Guang is with tense and aspect markers. Peacock (2007) describes rounding harmony in Nkonya as left-spreading. It appears to only affect tense-aspect markers in verbal constructions. These are /lɛ-/, /tɛ-/, /bɛ-/, and sometimes /dɛ-/. Both round vowels and labialized consonants can trigger rounding

harmony (2007: 25). Rounding spreads from the root, but does not spread past the tense aspect marker to the subject marker. The following example sets show rounding harmony in Nkonya, first when triggered by a round vowel (in (56) and then triggered by a labialized consonant (in (57)).

(56) Examples from Nkonya-vowel trigger (Peacock 2007: 25-26)

a. /bʊ̀-lɛ̀-kɔ́/ → [bʊ̀lɔ̀kɔ̀] 'they fought'

b. /ì-tɛ̀-tʊ́ àmʊ́/ → [ìtɔ̀tʊ́ámʊ́] 'it meets them'

c. /ì-bɛ́-bɔ̃̀/ → [ìbóbɔ̃̀] 'it will stink'

d. /ɔ̀-jɛ̀-túʔ ɔ̀-kpà/ → [ɔ̀jɔ̀tùɔ̀kpà] 'he travelled'[10]

(57) Examples from Nkonya-consonant trigger (Peacock 2007: 25-26)

a. /ɔ̀-bɛ́-kʷí:/ → [ɔ̀bɔ́kʷǐ:] 'she will give birth'

b. /n-bɛ́-kʷíʔ ɔ̀-bɔ́/ → [nbókʷìɔ̀bɔ́] 'I will dig'

c. /bʊ̀-tɛ̀-wí/ → [bùtòwí] 'they steal'

This process appears to be obligatory in Nkonya except with the irregular /dɛ⁻/, the continuous aspect marker. Note that labial consonants do not block rounding harmony, as in (56c).

Akanlig-Pare and Asante (2016) note that rounding harmony occurs in Nkami in a "highly restricted domain" of verbal prefixes. According to the authors, and unlike what we find in most other Guang languages, rounding harmony in Nkami is progressive. They state that it only occurs when the [+round] value of a subject pronoun spreads rightward to a tense-aspect marker. They have only identified two such pronouns which trigger rounding harmony in the following prefix. These are the second and third person subject pronouns [ɔ-] and [wʊ-]. All

[10] [jɛ-] is the northern dialect version of the perfective [lɛ-].

other subject pronouns have front, non-round vowels. The rounding only spreads to the perfect and progressive markers, which are both [lɛ-].

(58) Examples from Nkami (Akanlig-Pare & Asante 2016: 38-39)

a. /otu lɛ-dʊ/ or [ɔ-lɔ-dʊ] 'Otu has climbed/he has climbed'

b. /otu lɛ-dɪ/ or [ɔ-lɔ-dɪ] 'Otu has slept/ he has slept'

c. /wʊ-lɛ-dɪ/ → [wɔ-ɔ-dɪ] 'you are sleeping'

When the [+round] subject pronoun is attached, the vowel of the perfect or progressive marker becomes round. Note that in example (58a) it is not rounding in the root that will cause the perfective marker to become round. Example (58c) also shows a processes of /l/ deletion, and lowering of /ʊ/, or possibly deletion of /ʊ/. Depending on the order of these processes, this example may simply be a case of hiatus resolution, but the authors have included this in their examples illustrating rounding harmony. The authors also state that labialized consonants cannot trigger rounding harmony in Nkami, though the evidence they provide for this assumes regressive spreading from the stem, which is counter to the type of round spreading they have presented (2016: 39).

While Animah (2015: 35) states Cherepong does not exhibit rounding harmony, Bramson (1981: 16) gives examples of right-spreading harmony to progressive and perfect markers in the verb. Bramson has analyzed both of these to be underlyingly /o⁻/, though they have different tones. Bramson describes this harmony with the features [front] and [back].

(59) Examples from Cherepong (Bramson 1981:10)[11]

a. [mì-é-bírí] 'I'm playing'

[11] The copy I have of Bramson's work is not in perfect condition. It was difficult to make out these examples. I am fairly sure about all of them from the original and cross-checking transcriptions with Animah (2015), but I was unable to confirm this root [bʊrʊ] in (15d). The important thing here is that the root does contain [ʊ].

b. [mì-é-dì] ‘I’m sleeping’

c. [émù-ó-dʒí] ‘they are eating’

d. [wʊ́-ɔ̀-bʊ́rʊ̀] ‘you are beating’

Bramson states that the tense/aspect markers get their ATR value from the stem but they get their round value from the preceding subject marker. She appears to be claiming progressive spread of [⁻round], which typologically is unexpected. It is also unexpected to have an underlyingly [+ATR] prefix. It is likely that the progressive and perfect markers are underlyingly /ɛ⁻/, and that round subject markers spread round rightward.

5.2.4 Post-lexical Round Spread

Snider (1990b: 139) and Casali (1995b: 74) both record instances of post-lexical round spread across word boundaries. Snider notes that /a/ is opaque in this process as well as /ɛ/. He states this process is unbounded but often blocked beyond a single syllable. Examples (60c-d) show round spread being blocked.

(60) Examples from Chumburung (Snider 1990b: 139)

a. /okpe kuri/ → [okpo kuri] ‘witch’s husband’

b. /kofi kuduŋwi/ → [kofu kuduŋwi] ‘Kofi’s pain’

c. /ɔbrɪsɛ kʊkɔtɪʔ/ → [ɔbrɪsɛ kʊkɔtɪʔ] ‘elder’s egg’

d. /tɪŋ wʊrɪ/ → [tɪŋ wʊrɪ] ‘to cut skin’

Casali finds post-lexical round spread to be optional occurring mainly in fast speech, and the results to be gradient. He only finds this for word-final high front short vowels followed by a word in which the first vowel is round or the first sound is /w/.

(61) Examples from Nawuri (Casali 1995b: 74)

a. /afitiri lo:sa/ → [afitiru lo:sa] ‘grass for entering’

b. /ku:ri mɔ:sa/ → [ku:ru mɔ:sa] ‘pig for killing’

c. /mʊbi wɔtɪ/ → [mubuwɔtɪ] ‘his child pounded’

5.2.5 Comparison with Akan

Michael O’Keefe (2003) provides some insight into rounding harmony in Akan. As Akan is one of the most extensively studied Ghanaian languages, being closely related to Guang as well as being spoken in Guang areas, such resources have potential to shed some light on issues within Guang. I think it is noteworthy that rounding harmony is somewhat sporadic within Akan, only occurring in 4 prefixes in one dialect and in 2 suffixes in another (O’Keefe compares three dialects) (2003: 19). This is interesting, as it seems Guang languages show some similar variation with regards to rounding harmony.

O’Keefe shows that in the Fante dialect rounding will spread to the future, progressive, ingressive, and egressive prefixes.

(62) Examples from O’Keefe- Progressive tense (/rɪ⁻/) in the Fante dialect of Akan (2003:12)

a. [ɔ-rʊ-kɔ] ‘he is going’

b. [ɔ-rɪ-dɪ] ‘he is being called’

c. [o-ru-tu] ‘he is digging up’

d. [o-ri-bisa] ‘he is asking’

O’Keefe also states that a second dialect exhibits rounding harmony in certain suffixes. Examples of this, however, are more likely hiatus resolution.

5.3 Issues of round harmony and consonants

5.3.1 Inventories

In Guang, rounding harmony is closely tied in with issues of labialized consonants, as these may be triggers. There is some disagreement about the status of labialized consonants in Guang. Some have categorized them as phonemes but others just see them as CV or C^w sequences. For almost all of the consonant phonemes Snider (1990b: 7-8) has listed for

Chumburung, he has listed phonemic labialized counterparts. Hansford (1990: 50-51) gives a slightly different list of labialized consonants for Chumburung but does not seem to consider these phonemic, interpreting them as sequences of C plus the glide [ʷ]. Peacock (2007) also lists several labialized consonant phonemes in Nkonya. Casali (1995b: 11) lists 7 phonemic labialized consonants in Nawuri. Nelson et al. (2016: 106, 157) seem to interpret these sequences as consonant clusters and not separate phonemes, but they provide a list of these. Lenwah (1979: 31) includes only two labialized phonemes in his Gichode consonant chart, though there may be evidence of more in texts he provides. Plunkett (2009: 111) also does not list any labialized consonant phonemes, choosing to interpret all such sequences as CV. Akanlig-Pare and Asante (2016) transcribe these sequences in Nkami as consonant clusters. Obiri (2013: 50) lists labialized phonemic counterparts for about half of the consonant phonemes of Gua. Snider's Krachi wordlist (1989a) shows more labialized consonant phonemes than the Nawuri and Gonja lists, though not as full a set as he has given for Chumburung. Others, such as Obeng (2008: 6-7) and Agyeman (2016: 79) for Efutu, and Animah (2015: 31) and Bramson (1981: 10) for Cherepong, list relatively few phonemic labialized consonants. Blench (2015: 3-5) notes that Dompo does not exhibit much labialization of consonants and does not list any labialized phonemes. There are obviously some Guang languages for which we do not have much data on this subject. Table 5 shows the listed phonemes for each language.

Table 5 Labialized consonant phonemes in Guang

Language	**Labialized Phonemes**
Chumburung	pʷ, bʷ, tʷ, dʷ, kʷ, nʷ, ɲʷ, ŋʷ, fʷ, sʷ, tʃʷ, dʒʷ, lʷ, jʷ
Nawuri	pʷ, bʷ, kʷ, mʷ, fʷ, sʷ, tʃʷ
Gichode	dʷ, kʷ

Krachi	bʷ, tʷ, dʷ, kʷ, mʷ, fʷ, sʷ, ʧʷ
Gonja	bʷ, kʷ, fʷ, sʷ, lʷ
Nkonya	pʷ, bʷ, dʷ, kʷ, mʷ, ɲʷ, fʷ, sʷ, ʧʷ, ʤʷ, lʷ
Gua	bʷ, dʷ, kʷ, gʷ, fʷ, hʷ, ŋmʷ, ŋʷ, ʧʷ, lʷ
Cherepong	kʷ, gʷ, ŋʷ, fʷ, hʷ
Efutu	kʷ, ʧʷ, ʤʷ, ʃʷ, ɲʷ

5.3.2 Environments

Labialized consonants may also be restricted to specific environments. Both Casali (1995b) and Peacock (2007) have noted that phonemic labialized consonants in Nawuri and Nkonya only occur before non-round vowels. Before round vowels, labialized consonants are not contrastive. This pattern appears to be consistent across Guang languages. Snider (1990b: 51, 104) argues from his reconstruction that labialized consonants did not exist in Proto-Guang, but developed from de-rounding of adjacent vowels. Either the feature [round] spread to the consonant, or it was there and merely became contrastive when the following vowel derounded. Casali (1990) conducted some acoustic studies and found that consonants before round vowels have similar amounts of labialization as the phonemic round consonants. Blench (2015: 4) provides examples of labialized consonants in Dompo, all of which occur before non-round vowels. Examples from Obiri (2013: 65-68) show this same pattern. Hansford (1990: 50-51) also notes in Chumburung there is no contrast of Cʷ before back vowels, which are always round. He provides examples of Cʷ before /ɔ/, but states these only occur in fast speech.

5.3.3 Consonantal interference

Hulst and Weijer (1995: 526) summarize types of "consonantal interference" with vowel harmony. They note that most discussions of vowel harmony ignore consonants altogether as

they are not expected to play a role. This is not always true however, and we have seen this is not the case in Guang rounding harmony. First, consonants with secondary articulation, such as the labialized consonants, obviously may have an impact on vowel harmony. The second manner they describe, which we see in Guang, is consonants as targets of round spreading (Casali 1990: 331). The third type they mention is feature spreading from, or being blocked by, glides and consonants. The authors also note that the role of consonants in vowel harmony is not well understood, overall (Hulst & Weijer 1995: 530).

There is some variation within Guang with regards to consonantal interference in rounding harmony. As noted, Casali states that while labialized consonants can trigger rounding harmony to noun-class prefixes, plain (non-labialized) labial consonants will block rounding harmony in Nawuri. Again, Snider has described this blocking in Chumburung as well (2018: 102). Peacock (2007) also notes that labialized consonants can be triggers in Nkonya, and we find examples of this in Foodo. Elsewhere it seems that only a round vowel or /w/ can trigger rounding harmony. Peacock states that labial consonants do not block rounding harmony in Nkonya. Nelson et al. (2016: 135) also show that labial consonants do not block harmony, although they note some variation.

David Odden (1994: 322) has acknowledged this phenomenon in Nawuri, and notes the same pattern is found in Walpiri, an Australian language. He also describes similar patterns in other languages with features other than [round]. Though this pattern does seem unusual and Casali (1995c) has noted several models that would not allow for it, Odden's findings seem to show that it is possible and does occur in other languages. A full discussion of this issue is beyond the scope of this paper.

In the comparative wordlist compiled by Snider (1990b) I did find a few examples that appeared to show labial consonants blocking round spread in Gonja and Krachi. Again, Nelson et al. (2016) noted they found some variation in Gonja, in which round spread appeared to be blocked by labial and non-labial consonants, though this was in very few instances.

(63) Examples from Snider (1990b)

Gonja: [kɪpʊ] 'forest,' [kiboto] 'leprosy'

Krachi: [kɪkpɔʔ] 'knot'

These lists contained many more examples with labial consonants that did not block round spread, as in the example words in (64).

(64) Examples from Snider (1990b)

Gonja: [kumu] 'head,' [kʊbɔ] 'neck'

Krachi: [kupuni:ʔ] 'navel,' [kub^{w}ɪ:ʔ] 'louse,' [kʊbʊrʊrʊʔ] 'bile,' [kubu] 'stone'

5.4 Summary

Guang presents an interesting amount of variety with regards to rounding harmony. Based on Snider's (1990b) work we would expect to find rounding harmony in noun-class prefixes and perhaps nowhere else. In fact, we find that while at least several, if not all, North Guang languages do show rounding harmony in the noun-class prefixes, certain other Guang languages do not seem to exhibit this, but have rounding harmony in different environments. The patterns seen in Nkonya, Nkami, and Efutu are new in terms of Snider's study of Guang. Nkonya and Nkami, which are closely related, both exhibit rounding harmony in tense/aspect markers, though the patterns are fairly different. Rounding harmony in Nkonya is regressive as in other Guang languages, but it appears to be progressive in Nkami. Efutu exhibits rounding harmony in person markers. Again, Casali (1995b: 58-59) notes that just because rounding harmony appears

in only instance does not mean the rule should be written for that instance alone. Other factors may mean there are no other environments in a language where RH could apply.

This variation could be attributed to changes that have occurred over time among Guang languages. It is clear North and South Guang languages tend to operate differently from each other. Snider (1990b: 225-226) shows how the noun-class prefix /kI⁻/ was changed in Nkonya, and mostly lost in South Guang languages. It is easy to see how changes like these can lead to a variety of patterns for a process such as rounding harmony.

We also find some variation in the common triggers and targets of rounding harmony. The languages in which rounding harmony affects noun-class prefixes or person markers exhibit high vowels as the target[12] All of the tense-aspect marker targets have mid vowels. There has been almost no mention of vowel height for triggers of round harmony, other than Plunkett's mention that a high vowel is more likely to spread [round] than a mid-vowel or /w/. We also see that labialized consonants may act as triggers, but do not find evidence of this in all Guang languages. The following table displays the variation of rounding harmony in Guang.

Table 6 Rounding harmony in Guang languages

Language	Direction	Targets	Blocked by labial consonants	Obligatory/optional
Foodo	Regressive	noun class prefix	No	optional
Gonja	Regressive	noun class prefix	No	optional
Chumburung	Regressive	noun class prefix	Optionally, yes	
Nawuri	Regressive	noun class prefix	Yes	

[12] This is other than the case of /ka⁻/ in Gonja, which is also found in a few instances in Nawuri.

Nkonya	Regressive	Tense-aspect marker	No	obligatory
Cherepong	Progressive	Tense-aspect marker		obligatory, except irregular /dɛ-/
Nkami	Progressive	Tense-aspect marker		
Efutu	Regressive	Person marker		

6. Hiatus Resolution

In this section, I will provide a brief background on hiatus resolution. I will describe how it has been viewed in Guang languages. I will then discuss specific issues related to hiatus resolution in Guang.

6.1 General typological findings

Casali (2011: 1434) succinctly describes hiatus as "a sequence of adjacent vowels belonging to separate syllables." Many languages, including the Guang languages, do not easily accept or allow such sequences. Different means may be employed to disrupt the vowel sequence to allow it to fit better into the standard syllable patterns of the language.

There are a few common methods languages use to resolve hiatus; Casali (1998: 3-4) lists six. In the following discussion, V1 will signify the first vowel in the sequence and V2 will stand for the second. V3 will stand for a resulting vowel of coalescence. The first two processes described do not change the vowel sequence, but are more means of accounting for the existence of a vowel sequence. Heterosyllabification would simply allow the two vowels to remain in sequence, but in separate syllables. Diphthong formation would maintain the vowel sequence in a single syllable. A consonant, often a glide, may be inserted in between the two vowels in a process of epenthesis. One of the vowels may be deleted or elided. V1 may convert to a glide or semi-vowel. This is called glide formation. Finally, coalescence refers to the creation of a new, third vowel as some kind of compilation of the first two. This vowel may or may not be

lengthened through compensatory lengthening. A single language will often employ more than one of these strategies.

Casali has noted that different methods of hiatus resolution emerge in different morphosyntactic contexts. I have tried to describe which methods are used in which context in the Guang languages, and to note any patterns.

6.2 Hiatus resolution in Guang

The Guang languages employ several of these hiatus resolution strategies in different settings, but the primary methods we see in Guang are vowel elision, coalescence, and glide formation. In the case of elision, V1 deletion is more common than V2 elision cross-linguistically (Casali 1998) and this holds true in Guang languages as well, though some have reported V2 elision in Guang.

Snider (1990b: 128) and Casali (1998) have provided the most thorough descriptions of hiatus resolution in Guang languages. We may assume their findings are generally true across Guang languages, but with some differences.

The following example sets from Chumburung and Gichode display the main types of hiatus resolution in Guang: vowel elision, coalescence, and glide formation.

(65) Examples of elision (V1) in Chumburung (Snider 1990b: 141)

a. /de ɔŋarɪ/ → [dɔŋarɪ] ‘to have a man’

b. /ɔtʃapʊ ɔtʃɪʔ/ → [ɔtʃapɔtʃɪʔ] ‘doctor’s woman’

(66) Examples of coalescence from Gichode (Casali 1998: 169)

a. /dʒono ɪlɔ/ →[dʒonelɔ] ‘dog’s sores’

b. /dɪga idʒo/ → [dɪg**e**dʒo] ‘young man’s yams’

(67) Examples of glide formation in Chumburung (Snider 1990b: 128-129)

a. /abʊ ɪfɔ/ → [ab^{w}ɪfɔ] ‘it is far’

b. /ipurutu ɪsa/ → [ipurut^{w}isa] ‘three kapok pods’

As we have seen, ATR harmony is a pervasive process in Guang languages. It will play a role in hiatus resolution issues. Casali (1998) has written extensively about this. Essentially, he shows how languages with nine-vowel inventories, such as the Guang languages, will preserve [+ATR] in coalescence.

Snider (1990b: 157) gives a brief footnote that states that issues of vowel hiatus across morpheme boundaries in Chumburung will follow different rules than what has been described for hiatus across word boundaries. I believe it is due to these differences that we will see the most variation in hiatus resolution strategies in Guang languages. Snider and Casali have focused mainly on hiatus resolution across word boundaries of two lexical words. Several of the more recent descriptions of Guang languages have touched mainly on hiatus resolution in different contexts, such as compounds, affixes, and function words. These will be discussed in more detail in the following sections.

6.3 Vowel sequences and syllable types

The occurrence of hiatus resolution processes in Guang languages could lead us to assume that VV sequences are prohibited in all contexts. This section will look at where vowel sequences do occur in Guang languages or where they are reported to be acceptable.

Snider (1990b: 7) summarizes the main syllable types he has found for Chumburung as CV and CVN, with other types only occurring in specific settings. Though they are rare, Casali (1995b: 41-42) does find sequences of non-identical vowels in Nawuri. These will always include one high vowel. He interprets these, as Snider has, with intervening semi-vowels, as in VCV, instead of VV. This interpretation aligns better with the established syllable patterns of Nawuri. This interpretation is not contrastive with VV. He does not show any underlying diphthongs or non-identical vowel sequences (Casali 2002: 9).

In several descriptions of Guang languages transcriptions appear to show that VV sequences do occur. These include Nkonya, Larteh, Dompo, Gua, and Cherepong. Most, but not all, of these examples include one high vowel, so these sequences could also be interpreted as VCV sequences, with intervening semi-vowels. Peacock (2007: 16, 20) notes all such sequences always include a high vowel in Nkonya, however, he has chosen the analysis CV.V. Peacock, and Nelson et al. (2016: 151) have noted that V syllables only occur word-initially and word-finally, though the latter is not very common in Gonja. The following are examples of such transcriptions from three Guang linguists.

(68) Examples from Nkonya (Peacock 2007: 16)

a. [m̀-fú.ó] ‘flour’

b. [bí.ê] ‘bathe’

c. [ò-pí.ó] ‘sibling’

(69) Examples from Gonja (Nelson et al. 2016: 151)

a. [ǹwíê] ‘calabash’

b. [bèníô] ‘mother’

c. [èjàʊ̀] ‘price’

(70) Examples from Larteh (Ansah 2012: 120, 122).

a. [siɛ] ‘six’

b. [bùè] ‘take’

c. [okuafʊ] ‘farmer

According to Animah’s (2015) work on Cherepong, or Ɔkere, VV sequences are not rare in the language. She includes transcriptions with vowel sequences that differ in ATR value, do not contain a high vowel, or occur word medially.

(71) Examples from Cherepong (Animah 2015: 39, 37, 35)

a. [m̀fɔ́ɛ́] ‘oil’

b. [àboé][13] ‘an animal’

c. [èmiɛ́ní] ‘hair’

d. [ébíe] ‘lice’

Bramson’s (1981) account of the same language appears to show similar occurrences, though some examples she gives are of borrowed words. There is even one example that has three consecutive vowels: [gbuei], ‘dog’ (1981: 29).

Blench (2015) reports that vowel sequences are very rare in Dompo. A Dompo wordlist compiled by Dogbe (2018), however, shows several examples:

(72) Dompo examples (Dogbe 2018: 14, 24, 35, 41).

a. [kabue] ‘bird’

b. [tʃualɛ] ‘good’

c. [mbuaja] ‘stool’

d. [dið] ‘twenty’

Blench has transcriptions for some of these words which do not include VV sequences, but instead have sequences of semivowels and vowels (e.g. [kabwi] ‘bird’). Again, each sequence has a high vowel, so these could be interpreted as VCV sequences. It is interesting that some of the sequences occur word medially, as other Guang languages show a V syllable only occurring word-initially or word-finally.

Hansford (1990: 57-59) reports non-geminate VV sequences and geminate VVV sequences in Chumburung. He argues that, underlyingly, there is an intervening semi-vowel that

[13] Elsewhere this word has been transcribed [abʷe]. There may be an issue here, and with similar transcriptions, to do with orthographic norms. Also in (72a).

does not appear phonetically. While this description seems to be the reverse of others we have seen, this again points to the interesting inconsistencies that occur across Guang descriptions.

(73) Examples adapted from Chumburung (Hansford 1990: 58-59)

a. /kpàwʊ̀/ → [kpàʊ̀] 'deaf'

b. /tàjí/ → [tàí] 'to open'

c. /kwìíjì/ → [kwìíì] 'roan antelope'

d. /ánúwúrâ/ → [ánúúúrâ] 'evening greeting'

Across the descriptions I have seen of Guang languages there is a reasonable amount of evidence for VV sequences. If all of these sequences included one high vowel, we could explain all of them as VCV with intervening semi-vowels. Some examples could also be errors in the transcription, with one of the two vowels being a semivowel. I would especially expect this for the sequences that do not agree in ATR value. As this section is about hiatus resolution, we will generally assume that sequences of non-identical adjacent vowels are not favored in Guang languages.

These reports are interesting with regard to our topic of variation between Guang languages versus variation between Guang linguists. Based on what has been said by Snider and Casali, those who have done the most work on Guang languages, it would be easy to assume that these descriptions may contains some mistakes and/or inconsistencies with analysis and transcriptions of these sounds. This subject is given more coverage in Section 7.

6.4 Vowel elision

6.4.1 V1 elision

Vowel elision is one of the most common methods of hiatus resolution in Guang languages. As noted above, many of the descriptions of Guang languages have focused on hiatus resolution across a boundary between two lexical words. Casali (1998: 20) notes this particular

environment as one where he has not found V2 elision to occur cross-linguistically. He has written (1998: 8) extensively about which vowel will be deleted in hiatus scenarios, and has noted that it can be assumed that the vowel which occurs in the less-favored position is the one which will be deleted. A word-initial sound is more 'favored' or simply more important than a word-final sound. A root vowel will also be more favored than an affix vowel. Cross-linguistically, it would be more likely for a word-final sound to be elided than a word-initial sound as the word-initial sound is more important for a hearer's understanding of the speech. While it is far more common for V1 to be deleted, this is not the case in all morphosyntactic contexts (Casali 1998: 17, 20). This general pattern does seem to hold true across Guang languages. I have found no examples of V2 elision between two lexical words, with the exception of when V2 is part of a prefix. The following examples from Gonja show V1 elision in hiatus contexts.

(74) Examples from Gonja (Painter 1970: 91-97)[14]

a. /kéní: òjápìmbó/ → [kenojapimbo] 'he looked at Oyapimbo'

b. /dʒèbòté ísà:/ → [dʒèbòtísà] 'elephant Issa'

c. /kílɛ́ ètʃɛ́/ → [kílêtʃɛ́] 'he informed her'

d. /tà: òjápìmbó/ → [tò:jápìmbó] 'he brought Oyapimbo'

e. /kɔ́: ádʒɔ́/ → [ká:dʒá] 'he has yams'

f. /tò: àkùntùŋ/ → [twà:kùntùŋ] 'he shot the wolves'

g. /tú: ètʃɛ́/ → [twêtʃɛ́] 'he met the woman'

These examples are representative of the general process of vowel elision as hiatus resolution across Guang languages. Examples (74f, g) show glide formation.

[14] Note Painter did not include /ɪ/ and /ʊ/ in his vowel inventory of Gonja.

6.4.2 Compensatory lengthening

In the context of vowel elision as hiatus resolution, the main point of variability in Guang languages is compensatory lengthening. This is also an area in which Snider and Casali differ. Casali shows that the resultant vowel will appear as a long vowel in Nawuri, while Snider states that it will be normal length. Snider (1990b: 143) only describes one specific instance in Chumburung in which hiatus resolution will result in a long vowel. If the tone of V1 is low and the tone of V2 is high, the resulting vowel will be lengthened to accommodate both tones, unless some other process can deal with the disassociated low tone from the elided V1. The below examples show long resultant vowels in Nawuri and normal length resultant vowels in Chumburung.

(75) Examples from Nawuri (Casali 1995b: 77)

a. /kʊntɪ asɪ/ → [kʊnta:sɪ] 'near the elephant'

b. /na:tɪ ɔpɪ:/ → [na:tɔ:pɪ:] 'cow's tail'

c. /gibite obu/ → [gigito:bu] 'girl's room'

(76) Examples from Chumburung (Snider 1990b: 144)

a. /kúrì àkàtɔ̀/ → [kúràkàtɔ̀] 'husband's eyes'

b. /kúrì ɔ́fɔ́/ → [kúrɔ́fɔ́] 'husband's stranger'

Other descriptions of Guang languages show a variety of outcomes regarding lengthening. Examples of hiatus resolution in Gichode also show resultant vowels of normal length, though it should be noted these examples were also transcribed by Snider (Casali 1998: 168-169).

(77) Examples from Gichode (Casali 1998: 169)

a. /gibide ɪdʒaŋ/ → [gibidedʒaŋ] 'slave's thighs'

b. /atanatʃɪsɛ ɪlɔ/ → [atanatʃɪsɛlɔ] 'female twin's sores'

c. /dʒono ɪlɔ/ → [dʒon**e**lɔ] ‘dog’s sores’

According to Painter’s description (1970: 86) the resulting vowel will only be long if both V1 and V2 are [+back], or in the combination of [a] + [e] (see the examples in (74) above).

Plunkett (2009: 112) states that the resultant vowel of coalescence will be long in Foodo. The following examples show V1 elision due to hiatus with a suffix.

(78) Foodo examples with suffix /ˉU/[15] (Plunkett 2009: 125)

a. /fùùlì/ → [kúfúùlùú] ‘white’

b. /bìílì/ → [kúbíílùú] ‘black’

Peacock (2007: 27) describes compensatory lengthening after V1 elision in Nkonya, and Nkami displays lengthening as well (Akanlig-Pare & Asante 2016: 33). The following examples sets show how this phenomenon has been interpreted in Nkonya and Nkami.

(79) Examples from Nkonya (Peacock 2007: 27)

a. /ǹtá ónùkpà/ → [ǹtó:nûkpà] ‘drinking bar’

b. /àmbà èbíá/ → [àmbè:bíá] ‘Amba’s stool’

(80) Examples from Nkami (Akanlig-Pare & Asante 2016: 33)

a. [asa] ‘people’ + [ba] (NC) + [etwe] ‘eight’ → [asabeetwe] ‘eight people’

b. [asa] ‘people’ + [ba] (NC) + [ede] ‘eight’ → [asabeedu] ‘ten people’

This issue of compensatory lengthening is interesting; one single pattern does not seem to be emerging from the data. It is possible that in each language there are a number of factors that affect the length of the resultant vowel. Snider has shown that issues of tone can affect the outcome. Context or environment may also be a factor. It seems plausible that compensatory

[15] The /ku- -U/ affix pattern show in (78) is one agreement pattern in Foodo which causes these adjectives to agree with the noun-class.

lengthening could still be generalized for Guang languages as most of the authors report this. This topic is discussed further in Section 7.

6.4.3 V2 elision?

While V1 elision is the expected form of hiatus resolution in Guang, some have reported V2 elision in specific contexts. Obiri (2013) and Ansah (2012) have both described V2 elision in the case of compound formation in Gua and Larteh.

(81) Examples of Compound words from Gua (Obiri 2013: 83)

a. /æŋɛ́/ 'man' + /anûm/ 'elder' → [æŋɛ́nûm] 'elderly man'

b. /tèí/ 'food' + /ækɔ́sì/ 'good' → [tèíkɔ́sì] 'good food'

c. /ésíbi/ 'eye' + /alé 'difficult' → [esibilé] 'courage'

(82) Examples of Compound words from Larteh (Ansah 2012: 118, 121)[16]

a. /ó-wúrɛ̀/ 'chief' + /áwú/ 'home' → [ówúréwù] 'palace'

b. /ɔ̀kyí/ 'female' + /ònúmú/ 'elderly'→ [ɔ̀kyínúḿ] 'elderly woman'

c. /ònyínɛ́/ 'male' + /ònúmú/ 'elderly' → [ònyínɛ́núḿ] 'elderly man'

d. /óbí/ 'child' + /ònyínɛ̀/ 'male' → [òbìnyínɛ̀] 'son'

Based on the above examples alone, it would appear that these authors have found a context in which V2 is elided. However, there may be an alternative explanation for these examples. It could be argued that these compounds do not present a case of hiatus at all. All of the V2 vowels in the above examples are noun-class prefixes. Snider (1990b: 24-25) has shown that, at least in the case of Chumburung, compounding of the stems occurs before any noun-class prefix is attached. The noun-class prefix of the compound may be different than those of the two stems in their citation forms, but the compound will have a single prefix fitting its semantic

[16] Examples (82b, c) show a word-final [u] deletes and its tone is transferred to the nasal.

category. It seems likely that the above examples do not actually show hiatus, as V2 is not really present. The process we are seeing is a combining of stems with [+ATR] spreading to the word-final vowel.

The following examples show more clearly how Snider has interpreted compounds by noting the morpheme breaks.

(83) Examples of Compounding in Chumburung (Snider 1990b: 25)

a. /kà-bíʔ/ 'mountain' + /kí-dʒí/ 'seed' → [kə̀-bí-dʒí] 'hill'

b. /kùbé/ 'coconut' + /kí-jí/ 'tree' → [kù-kùbéjí] 'coconut tree'

Snider shows the noun-class prefixes in the underlying form, but these are not included in the second half of the compound.

The idea that the above examples from Obiri and Animah are not actually examples of hiatus may also be evidenced by the tone patterns. With any vowel elision, we would expect, in many African tone languages, to see tone stability (Goldsmith 1976: 397), or the tone of the deleted vowel shifting to a nearby tone bearing unit. This process is known to exist in other Guang languages (Snider 1990b). In the above examples there is no appearance of these tones, again suggesting that the V2 vowels were never present in the compounding process.

Akanlig-Pare and Asante (2016) have not specifically addressed issues of hiatus resolution in Nkami, however they raise an interesting issue or question regarding hiatus in compounds.

(84) Examples Akanlig-Pare and Asante (2016: 33)

a. /ntʃɛ etwe/ → [ntʃetwe] 'eight days'

b. /ntʃɛ edu/ → [ntʃedu] 'ten days'

c. /ntʃɛ anu/ → [ntʃɛnu] 'five days'

d. /ntʃɛ asie/ → [ntʃɛsie] ‘six days’

These examples show [+ATR] spreads to the initial stem when the noun-class prefix is [e], but not when it is [a]. Again, in this compounding process, we could assume the noun-class markers for the numbers are not actually present, and therefore not deleted. However, examples (84c, d) appear to show that the noun-class marker [a] has blocked [+ATR] from spreading to the preceding vowel. The authors hypothesize that the order of the processes may mean that [+ATR] is blocked before /a/ is deleted, or that the [-ATR] value of /a/ is lingering and blocks the [+ATR] spread. Snider (personal communication) notes that, in the case of number words, the noun-class prefix vowels are present in the compounding process.

6.4.4 Prefixes

Based on Casali’s analysis and evidence from Guang descriptions, hiatus between a prefix and a root will occur in the same way as hiatus between two words in Guang. Such occurrences are rare as most roots begin with consonants. However, I have encountered at least one possible instance of hiatus between two prefixes. This situation in Efutu poses some complexity. Casali’s (1998: 43) analysis shows that V1 elision is significantly more prominent in this context as well. Agyeman (2016: 92) claims V1 elision with certain vowel combination and V2 elision for others. The prefixes involved are person markers followed by grammatical tense or negation markers. The examples she gives include the person markers [mɪ], [anɪ], [mʊ], and [amʊ] attaching to future, progressive, or negation markers [áà], [àá], and [áá]. In her examples, V1 is deleted when it is [ɪ], but when V1 is [ʊ], the following [a] is deleted (Agyeman 2016: 88, 91).

(85) Examples from Efutu (Agyeman 2016: 87, 89) of V1 deletion

a. /mɪ-áà-wɔ́/ → [m-áà-wɔ́] ‘I will go’

b. /mɪ-àá-wɔ́/ → [m-àá-wɔ́] ‘I am going’

c. /ánɪ-áà-wɔ́/ → [án-áà-wɔ́] ‘you will go’

d. /mɪ-áá-wɔ́/ → [m-áá-wɔ́] ‘I will not go’

(86) Examples of V2 deletion (Agyeman 2016: 91)

a. /mʊ-àá-wɔ/ → [mʊ̀-á-wɔ́] ‘s/he is going’

b. /amʊ- àá -wɔ/ → [àmʊ̀-á-wɔ́] ‘they are going’

Once again, this analysis of V2 elision may be called into question. These examples may instead be analyzed as having a single long vowel in the tense marker which is shortened in the process of heterosyllabification. This is a common process, cross-linguistically.

6.4.5 Suffixes

Casali’s study (1998: 38-39) showed that for hiatus between a root and a suffix, more languages only delete V1 in this context than those that only delete V2. He also found several languages that employ V1 and V2 elision in different contexts of root-suffix hiatus. He includes Nawuri in the list of languages which only delete V1 here.

Plunkett (2009) also shows V1 elision in this context with a suffix he has labeled /ˉU/[17]. Note this process with this suffix seems to only occur with a high V1. Here V1 is elided and the suffix will be lengthened. The suffix will agree with the ATR value of the root.

(87) Foodo examples with /ˉU/ (Plunkett 2009: 125)

a. /bɔ̀ɔ̀lì/ → [kʊ́bɔ́ɔ̀lʊ̀ʊ́] ‘raw’

b. /káálí/ → [kʊ̀káálʊ́ʊ́] ‘small’

c. /kpààlɪ/ → [kʊ́kpáàlʊ̀ʊ́] ‘good’

d. /pɔ̀ɔlì/ → [kʊ́pɔ́ɔ̀lʊ̀ʊ́] ‘new’

[17] Again, this suffix is part of an agreement pattern which agrees with a certain noun-class.

6.4.6 In fast speech

Plunkett (2009: 113-114) describes a process across word boundaries in fast speech in Foodo. According to Plunkett this process only occurs with conjunctions [nɪ] and [la] and a complementizer [jɛ]. He shows that when these words occur before a word beginning with a vowel, the V1 in the conjunction or complementizer will totally assimilate to the V2.

(88) Examples from Foodo (Plunkett 2009: 113-114)

a. /ní ɔ̀sɔ̀ɔ̀/ → [nɔ́ɔ̀sɔ̀ɔ̀] 'and buy'

b. /jɛ̀ ɔ̀bɔ́ó àtɔ́lì/ → [jɔ̀ɔ̀bɔ́ó àtɔ́lì] 'the hut had fallen'

c. /là ítà/ → [lɛ̀ɛ́tà] 'and finish'

Note example (88c) shows that a [+high] V2 will still be lowered by a [⁻high] V1. It would be possible, and perhaps more accurate, to analyze the process in (88) as V1 elision with compensatory lengthening, as we have seen elsewhere, and in other contexts within Foodo.

6.5 Coalescence

Coalescence refers to the merger of the two vowels in hiatus into a third distinct vowel which may or may not be long (Casali 1998: 4). This resultant vowel is referred to as V3. It is difficult to separate coalescence from elision as a distinct process. According to Snider's (1990b: 127) description, coalescence and elision may go hand in hand. He describes coalescence as the assimilation that happens to V2 before V1 is deleted. The following examples show coalescence as hiatus resolution in Gichode. V3 is bolded.

(89) Examples from Gichode (Casali 1998: 169)

a. /dʒono itʃiŋ/ → [dʒon**e**tʃiŋ] 'dog's veins'

b. /dɪga idʒo/ → [dɪg**e**dʒo] 'young man's yams'

c. /atanatʃɪsɛ itʃiŋ/ → [atanatʃɪs**e**tʃiŋ] 'female twin's veins'

These examples show [+ATR] is preserved, [‑high] in V1 is preserved, and the front/back value of V2 is preserved.

Plunkett (2009) shows that coalescence will occur due to hiatus with a noun-class suffix, /‑a/, unless the preceding root vowel is [a]. If V1 is high, it will be lowered to a mid-vowel. The resulting vowel is always long.

(90) Examples from Foodo (Plunkett 2009: 113, 117, 119)

a. /ń-lí-á/ → [ńléè] ‘funerals’

b. /ń-sú-á/ → [ńsóò] ‘years’

c. /à-jɛ́-á/ → [àjɛ́è] ‘cheeks’

d. /à-sʊ́-á/ → [àsɔ́ɔ́] ‘ears’

e. /a-jòsì-á/ → [ájóséé] ‘yam mounds’

This process is notable as it shows a kind of reversal of the rules Snider has given for coalescence, since V1 is in the root it is in the more salient position. Though Foodo has other /‑V/ suffixes, Plunkett only notes this one as causing coalescence. The others appear to show elision or heterosyllabification.

6.6 Glide formation

Glide formation is also a very common form of hiatus resolution in Guang. This occurs when V1 is round and V2 is not round. It is less common for the [j] glide to form when V1 is [i], though it happens in some languages. Painter (1970: 87) says this only happens in Gonja when V1 is [i] and V2 is [a]. The following examples show glide formation in Gonja, Nawuri, and Chumburung.

(91) Examples from Gonja (Painter 1970: 91, 95)

a. /kéní: áfɔ́/ → [kénjáfɔ́] ‘he looked at’

b. /kɔ́: ísà/→ [kwísà] ‘he wrestled with Isa’

c. /kɔ́: ètʃé/ → [kwêtʃé] ‘he wrestled with the woman’

(92) Examples from Nawuri (Casali 1995b: 78)

a. /gudu asa/ → [gud^{w}a:sa] ‘thirteen’

b. /fʊ ɪpʊ/ → [f^{w}ɪ:pʊ] ‘your soup’

c. /afɔ asa/ → [af^{w}a:sa] ‘three strangers’

(93) Examples from Chumburung (Snider 1990b: 16)

a. /a-bʊ ɪ-fɔ/ → [ab^{w}ɪfɔ] ‘it is far’

b. /i-purutu ɪ-sa/ → [ipurut^{w}isa] ‘three kapok pods’

c. /i-dʒo ɪ-sa/ → [idʒ^{w}esa] ‘three yams’

The following examples from Nawuri show that a glide will not form from a round V1, if V2 is also round, or simply will not be perceptible.

(94) Examples from Nawuri (Casali 1995b: 77)

a. /fʊ obu/ → [fo:bu] ‘your room’

b. /ɔbʊ obuto/ → [obo:buto] ‘he is in the room’

6.7 Epenthesis

6.7.1 The glottal stop and long vowels

Epenthesis occurs in Guang as hiatus resolution less often than the other methods I have discussed. Snider (1990b: 130-131) specifically notes that words which end with a glottal stop in Chumburung will not experience vowel elision in the case of hiatus resolution, even when the glottal stop is deleted. In Chumburung the glottal stop is deleted and a semi-vowel is epenthesized between the two vowels. Finally, V1 will be raised to assimilate to the semi vowel, either [w] or [j]. Epenthesized semivowels in the following examples are bolded.

(95) Examples from Chumburung (Snider 1990b: 130)

a. /akɔbɛʔ asa/ → [akɔbɪ**j**asa] ‘three relatives’

b. /ibodobodoʔ ɪsa/ → [ibodoboduwesa] ‘three loaves’

c. /dɔʔ ɪsɪ/ → [dʊwɛsɪ] ‘to hoe soil’

A different explanation for this phenomenon comes from Hansford (1990: 54). He believes that these utterance final glottal stops indicate underlying long vowels. Snider (personal communication) notes that today he agrees with Hansford’s interpretation. He (Snider 2019) has described this phenomenon of glottal stops being added and therefore long vowels shortened utterance finally in his recent work on vowel length in Chumburung. This explanation would make the above examples pattern as follows:

(96) Examples adapted from Snider (1990b: 130)

a. /akɔbɛɛ asa/ → [akɔbɪjasa] ‘three relatives’

b. /ibodobodoo ɪsa/ → [ibodoboduwesa] ‘three loaves’

c. /dɔɔ ɪsɪ/ → [dʊwɛsɪ] ‘to hoe soil’

This is notable, as we also see epenthesis following a long vowel in some examples from Foodo.

(97) Examples from Foodo (Plunkett 2009: 119)

a. /ka-li-a/ → [kélíjà] ‘funeral’

b. /ka-su-a/ → [késúwà] ‘year’

c. /ka-kii-a/ → [kèkìjá] ‘knife’

d. /ka-dɔ̀ɔ̀-a/ → [kàdɔ́wá] ‘field’

All of the above examples show epenthesis, but only (97c, d) have long vowels for V1. While it is not entirely clear, and not consistent in the provided examples, Plunkett notes that within a particular agreement pattern, long or double vowels trigger the epenthesis of a semi-vowel.

Examples from Casali support the idea that utterance-final glottal stops indicate long-vowels.

(98) Examples from Nawuri (Casali 1995b: 79-80)

a. /ako:ʔ/ ‘parrot’
/ako: aɲɔ/ → [aku:aɲɔ] ‘two parrots’

b. /afule:ʔ/ ‘money’
/afule: asa/ → [afuli:asa] ‘three monetary notes’

c. /sɔ:ʔ/ ‘to buy’
/sɔ: ɪpɔ/ → [sʷɪ:ɛpʊ] ‘buy soup’

These examples show, as Snider’s do above, that non-high, word-final long vowels in hiatus will be raised to high vowels. Also, high V2 vowels are lowered. While Snider seems to attribute the raising of the word-final vowel to assimilation to the semivowel, as in the examples in (95) (above) this could also confirm that the V1 vowels are long. This raising can be seen in the examples (98b, c).

Casali (1995b) shows a different process of hiatus resolution with long vowels in Nawuri. He notes that /a:/ as V1 will be elided, like any short V1, but all other long vowels as V1 will resist deletion.

(99) Examples from Nawuri (Casali 1995b: 77)

a. /kpa:ra: ɔbɔ/ → [kpa:rɔ:bɔ] ‘squirrel’s hole’

b. /ta: ɔlɔpʊmʊ/ → [tɔ:lɔpʊmʊ] ‘take the sick person’

c. /si: obuto/ → [si:obuto] ‘remain in the room’

d. /dʒe: obuto/ → [dʒe:obuto] ‘bathe in the room’

e. /bu: ɔɲɪŋ mʊ/ → [bu:ɔɲɪmmʊ] ‘follow the man’

As examples (99c-e) show heterosyllabification, perhaps they could be interpreted as having an intervening glide, as Snider and Plunkett’s examples show.

6.7.2 Other examples of epenthesis

Agyeman (2016: 96) claims certain contexts will lead to the epenthesis of a consonant as hiatus resolution in Efutu. In the examples below the epenthesized consonants are in bold.

(100) Examples from Efutu (Agyeman 2016: 95-96)

a. /ɔ-áà-wɔ/ → [ɔ́-**b**áà-wɔ́] 'you will go'

b. /ɔ-àá-wɔ/ → [ɔ̀-**n**àá-wɔ́] 'you are going'

c. /anɪ-áá-wɔ/ → [àní-**m**áá-wɔ́] 'we will not go'

These are interesting examples, and may present a case of misanalysis. It seems likely that the consonants are a part of the individual morphemes underlyingly and are deleted elsewhere, instead of epenthesized here. It would be very unusual for specific consonants to be epenthesized with specific grammatical markers. I would conclude these are not examples of epenthesis as hiatus resolution, but some other process. I include them to contrast with the above examples with epenthesized semi-vowels, which are much more like what would be expected in such contexts.

6.8 Summary

As we have seen, hiatus resolution in Guang occurs primarily through V1 elision, coalescence, and glide formation. It occurs in hiatus between two words, and sometimes between roots and affixes. These environments vary somewhat language to language. Overall, VV sequences are not acceptable in Guang languages. Where such sequences do appear to occur, most if not all are likely CV or VCV sequences, where C is a semi-vowel.

7. The bigger picture of Guang vowel systems

What kind of picture does this study provide of Guang vowel systems? Where do real variations exist, and what is the same across the board? This section will attempt to summarize some answers to these questions.

7.1 Primary variations

In the previous sections we have seen a good deal of variation among Guang languages. A helpful question to ask here may be: Does this difference represent variation in Guang, or variation in linguists' analyses of Guang languages? At this stage, it is not possible to definitively answer this question, but it could be applied to many of these areas of variation. I would suspect we find the answer is almost always both. There is of course variation in Guang in certain aspects. But there is also certainly variation between descriptions of processes or occurrences that are actually the same. Each of these issues would likely require further analysis, possibly acoustic study, and other means to fully answer. At this point I just wish to present the main areas of variation and perhaps call some into question, or simply note where descriptions may be merged. These issues are highly relevant to a well-rounded perspective of field work and language description and will point to some lessons I will discuss in the following section.

7.1.1 The dominant suffix

The existence of dominant [+ATR] suffixes is highly significant as they provide one of the main arguments for [+ATR] dominance in Guang. It is interesting that not all cognate suffixes are dominant across Guang languages. Some of the variation reported in this area may just require further analysis. Dundaa notes that the diminutive suffix [ˉbi] sometimes spreads [+ATR] in Krachi. Based on evidence from closely related languages such as Chumburung, we could guess that the suffix is also dominant in Krachi. Elsewhere it is clear that this suffix is not dominant. In Gonja the suffix harmonizes with the root. Bramson reports that [ˉbi] is invariable in Cherepong, but does not spread [+ATR] to the root. This is very unusual in the Guang languages, though some transcriptions from Obeng (2008) may show a similar case in Efutu. The presence of this suffix is still very valuable, and it may be argued that it was dominant and

[+ATR] at one time in all Guang languages or perhaps all North Guang languages, and has experienced a change in some of them.

7.1.2 Issues of the low vowel

The patterns of /a/ in ATR harmony is another area of variation. It seems clear that /a/ is opaque to [+ATR] harmony in Nkonya and Nkami. Larteh may also display this pattern. Chumburung, Nawuri, and Gua show /a/ will change to its allophone and allow [+ATR] to spread beyond it. Foodo appears to display a true case of transparency. However, it is possible that Foodo also aligns with the pattern of Chumburung. I will discuss this further in section 7.2.

7.1.3 Vowel sequences

There appears to be variation in patterns of vowel sequences across Guang languages. Due to ATR and rounding harmony, hiatus resolution, and other processes of assimilation, it is somewhat surprising to still find sequences of adjacent vowels in Guang. Certain descriptions seem to show many vowel sequences, such as Animah's description of Cherepong. As noted, Snider and Casali have interpreted these as VCV sequences, with intervening semi-vowels. VV sequences of course do exist in Guang, but also it is possible that many of these that have been transcribed as VV are in fact VCV.

The variation between Blench and Dogbe's accounts of Dompo may be emblematic of other variation issues in Guang. In certain places where Dogbe has transcribed a vowel sequence, Blench has a CV sequence with a semivowel. As these two types of transcriptions do not necessarily represent an audible difference, this appears to be a case of different preferences or tendencies in transcribing. However, as adjacent vowels lead to phonological processes across word or morpheme boundaries in these languages, it may be helpful to set a standard for Guang languages to help distinguish types of sequences. It is likely that some of the variation we see in

Guang could simply be attributed to variations of accounts by different linguists, as in this example from Blench and Dogbe.

7.1.4 Compensatory lengthening in hiatus resolution

The different reports on vowel length following elision due to hiatus resolution present another interesting area of variation. This is particularly interesting as Snider and Casali report different outcomes. It is certainly not out of the question that Chumburung behaves one way and Nawuri another. Snider also reports vowels of normal length in Gichode, and Painter notes that only certain circumstances will lead to a lengthened vowel. Elsewhere it appears that vowel elision leads to compensatory lengthening. This issue may present a true instance of variation across Guang languages., however Snider (personal communication) notes that an acoustic study may reveal that these vowels are lengthened in Chumburung as well.

7.2 Remaining disagreements

The main point that I would still question in certain languages is the issue of the [+ATR] allophone of /a/. Plunkett (1991, 2009) and Akanlig-Pare and Asante (2016) have claimed there is no such allophone in Foodo and Nkami, respectively. My acoustic analysis of Nkami data seems to indicate that this allophone does exist in Nkami. Acoustic measurements show a [+ATR] version of /a/ in environments where it is likely the allophone would be present. With regards to Foodo, Plunkett is not very firm that the allophone does not exist. He states it may exist in Foodo, but if it does it is very difficult to hear and distinguish (1991: 36). Based on the evidence from other Guang languages, and from Foodo, it seems highly possible that a [+ATR] allophone of /a/ does exist in the language. If this was true, it could clarify some other areas of variation. Above, I noted variation with patterns of /a/ in ATR harmony amongst Guang languages. Foodo was listed as having the only case of true transparency as /a/ allowed [+ATR] to pass through it but was not itself changed. If a [+ATR] allophone of /a/ does exist in Foodo,

then the Foodo pattern of ATR harmony with regards to /a/ would match all other Guang languages where /a/ is not opaque to [+ATR] spread. It would be simple to evaluate this question if there were accessible recordings of Foodo. I will discuss this issue more in Section 8.

7.3 Consistent aspects of Guang vowel phenomena

Though we find some notable and interesting variations, it is clear that there are more aspects that are consistent across Guang languages, with regard to vowels, than there are variations.

7.3.1 Nine-vowel systems

The most important feature that we find the same across Guang languages is the nine-vowel system. As noted above, historically in the study of Guang, various languages have been labelled as having seven, nine, or ten vowel systems. Dakubu (1988) includes all three of these possibilities in her listings on Guang languages.

Snider (1989b) and others have noted that all Guang languages likely have nine-vowel systems, but it bears repeating, however, as several works on Guang still report seven or ten vowel systems. In his reconstruction of Proto-Guang, Snider (1989c, 1990b) lists 7 vowels, but he notes /e/ and /o/ have since been added to the inventories of most or all of the Guang languages. As recently as 2015 Blench reported that Dompo has only seven vowel phonemes. Dogbe's Dompo wordlist (2018) appears to show all nine vowels, including /ɪ/ and /ʊ/. Obiri (2013) also cites ten vowel phonemes for Gua, though Obeng (1995) listed nine. Despite these varying reports there seems to be no substantial evidence to show that any Guang language has anything other than a nine-vowel system.

This fact has interesting typological and theoretical implications. /ɪ/ and /ʊ/ have historically been thought to be marked (Archangeli & Pulleyblank 1994), as high vowels raise the tongue body, which may pull the tongue root forward, and these vowels do not have a raised

tongue root. These vowels have also been assumed to be easily lost over time because of their level of markedness (Casali 2008: 511). It is interesting then that all Guang languages appear to have "stable" nine-vowel systems, with no evidence of loss of /ɪ/ and /ʊ/. Akanlig-Pare and Asante (2016) also note that it is common for /ɪ/ and /ʊ/ to be lost, but state that these phonemes do not appear to be marked, or even used less frequently in Nkami. If /ɪ/ and /ʊ/ were marked in Guang languages they would occur less often than other vowels, but this does not seem to be the case in any Guang language.

7.3.2 Other consistent aspects

The list of vowel phenomena that are consistent across Guang languages could be very lengthy. I will just highlight a few more of the prominent ones here. In conjunction with the standard of the nine-vowel system, Guang languages each exhibit nine long vowel phonemes. We have discussed [+ATR] dominance and left-spreading [+ATR] harmony and rounding harmony. Patterns of hiatus resolution are fairly consistent, with the most common method of resolution being V1 elision. This is notable, as V2 elision was indicated in certain languages/contexts.

8. Lessons learned and concluding thoughts

What lessons can be gathered from this study of Guang vowel phenomena? As noted, the study of Guang languages has historically featured a good deal of varying analyses. In recent years, with more in-depth studies, a lot of these issues have been resolved. From this survey of materials and resources spanning several decades many lessons can also be learned regarding best research practices.

8.1 Acoustic analysis

Acoustic analysis has been used effectively in analyzing several of the Guang languages. Acoustic study has greatly helped clarify issues of vowel inventories for descriptions of Guang

languages. After reading these works on Guang languages as well as conducting some of my own acoustic analysis, I would highly recommend acoustic study for better analysis and description of Guang languages. While it may not provide definitive results, acoustic analysis can help inform on differences between ATR pairs, as well as between high [-ATR] and mid [+ATR] vowels. Acoustic analysis has also proven valuable in the case of the allophone of the low vowel. I was able to take acoustic measurements to evaluate the presence of this allophone in Nkami. Based on recordings and acoustic measurements I was able to determine that the data set did in fact include the [ạ] allophone, though it had been said to not exist in the language.

I was also able to take acoustic measurements to evaluate [+ATR] spread in Gonja. In this preliminary study, such measurements are not entirely definitive. These measurements appear to show a pattern of /a/ allowing [+ATR] to spread beyond it, though it is perhaps gradient. Acoustic measurements in this scenario are extremely helpful in displaying initial patterns and providing some quantifiable data.

Starwalt (2008) undertook an extensive acoustic study of several African languages, including Foodo, with the aim of be able to better distinguish high [-ATR] vowels from mid [+ATR] vowels. Her level of analysis is very in-depth and beyond the scope of this paper, but it demonstrates how acoustic analysis can be used to answer remaining questions related to vowel inventories and phenomena.

A question that has come up in the course of this study is the issue of compensatory lengthening following vowel elision in hiatus contexts. Acoustic analysis could be very valuable in determining if and where there is compensatory lengthening.

8.2 Best research practices

Based on my survey of existing resources on Guang it seems there is definitely room for improvement with regards to best research and description practices. It seems that there are many

works on Guang that are not easily accessible for other linguists to make use of. Other times it seems that previous work on a language was simply not cited or adequately referenced. Many descriptions of Guang languages make reference to Akan, as well as other Guang languages, but there are some in which not all relevant materials were consulted. For example, two of the prominent sources on the Gua language and its vowel harmony do not cite previous works. Obiri's (2013) work on Gua does not reference Obeng's (1995) work on the same language, and Obeng doesn't cite Painter's earlier works on Gua. Even for this study, I was not able to obtain all relevant sources.

Such omissions can also lead to confusion and misinterpretation. Obeng and Agyeman have both published works on Efutu, and Agyeman does make reference to Obeng, but not in every area of her description where Obeng's work could provide some insight. It seems that where Agyeman (2016: 94) described occasional epenthesis of consonants with tense markers (mentioned above), Obeng actually interpreted this as deletion (the consonants are there underlyingly and are sometimes elided). Agyeman doesn't reference Obeng's earlier analysis here. For the most part, Guang linguists adequately make use of available relevant materials, but there are certainly some instances for which materials either were not accessible or were not referenced.

In conjunction with this issue, many works on Guang languages are not easily accessible to be made use of for further study. Lenwah's (1979) work on Gichode seems to only be referenced once by Casali (2002). Plunkett's thesis on Foodo has been referenced, but seems to not be available anywhere online, and is only in two libraries according to WorldCat. GILLBT (Ghana Institute of Linguistics, Literacy and Bible Translation) has not made many of its resources on Guang, such as Dundaa's (2000) work on Krachi, easily accessible or available

online. Another example is a resource called West African Language Data Sheets from 1977 edited by Kropp-Dakubu. This work contains information on 42 languages, including preliminary data for Efutu, Ginyanga, Gichode, and Krachi. It is designed to include brief phonological and grammatical descriptions, as well as a list of 50 words, 129 sentences or phrases, and numbers one to ten for each language, though it appears a few sections are missing for some languages. This resource is not cited in many of the works I have consulted and is not easily accessible. This collection is somewhat unique in its format, and may be especially of interest for the number of transcribed sentences and phrases it contains for each language. While this resource may be considered old now, and doesn't contain much description, it does contain a lot of data. It is unusual that it hasn't had much effect, at least in the study of Guang languages.

As I have noted in an earlier section, something that could make a big impact in this area would be accessible quality recordings of Guang languages. UCLA phonetics lab language archive does have recordings from 1962 made by Peter Ladefoged for Efutu, Gua, Krachi, Larteh, and Nkonya. These each have a short wordlist of about 20 words. This is a good resource, but not very extensive for any one language. There is an online Nkonya dictionary (provided by SIL and GILLBT on webonary.org) that includes recordings for many words, as well as recordings of full sentences to exemplify the word. There are also wordlists for Gonja, Krachi, and Nawuri available on ComparaLex (comparalex.org). It would be very beneficial to have similar databases for other Guang languages. As noted above, language recordings could help answer questions such as that of the [+ATR] allophone of the low vowel in Foodo or issues of VV sequences versus sequences of semi-vowels and vowels.

Blench (2019) recently gave a talk outlining a method to improve research practices for Nigerian languages. He has seen how variation between reports, lack of good access to data, and

lack of communication can lead to various problems. He argues for a systematic, step-by-step approach to lead to really good linguistic study with the outcome of usable materials. Ideally for Blench, all previous materials would be adequately digitized, which likely means retyping not just scanning, and easily accessible. He then provides a clear kind of timeline or outline for study. He argues for starting with sociolinguistic survey, followed by full review of the literature, followed by linguistic analysis.

I think Blench has outlined a good approach, and that it could be useful if applied to Guang or Guang languages. However, it seems like it would require a specific concerted effort from an induvial or organization, likely working in conjunction with other linguists, and following a careful plan. Not every organization has the same end goal as Blench, and it may be difficult to assemble a team to carry out such a task.

8.3 Areas for further study

There are many areas in Guang that could benefit from further study. Several Guang languages do not have full phonological analyses. It would be helpful to have a fuller picture of Dompo, Gichode, and others. At this time, Blench's work (2015) on Dompo is the most comprehensive, but it does not include much phonological analysis, though Dogbe may be working on this language. It would also be useful to have a clearer picture of the South Guang languages. Recent works have been published for all four, Gua, Efutu, Larteh, and Cherepong, but only Obiri's (2013) study on Gua had a strong phonological focus. Agyeman's (2016) dissertation on Efutu is a grammar with sections on the phonology of the language. Most of Ansah's works on Larteh deal with morphology and syntax and her *Aspects of Latɛ Phonology* (2002) is not easily accessible. Similarly, Animah's (2015) work on Cherepong is about focus constructions in the language. Again, it includes some phonological description. There are several other languages

that are listed in the Guang family, which each have even fewer resources available or accessible. These include Nchumbulu, Tchumbuli, and Ginyanga.

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Appendices

Appendix A: Nkami words analyzed

[+ATR]	[-ATR]
ạbạtiʔ	abɛ
ạbạtʃụɛʔ	abɔdʒɪsɛ
ạbiʔ	abʊɾɔʔ
ạbɾẹŋạwʔ	afɔ
ạdʒạfiʔ	afɔbʊ
ạfieʔ	aja
ạfu	akaʔ
ạŋie	akʊ̃
ạŋiʔ	akʊ̃
ạtumpa	akʊsɾadɪ
awuniʔ	alʊbʊ
abi	aŋɛsɪ
	aŋɪnɪ
	aŋɔ
	asa
	asɪ
	asɪɾaʔ
	asʊ̃
	aswɪʔ
	atabʊ
	atĭɾebiʔ
	atɔ
	atʃɛ
	atʃɪ
	awanɪʔ
	awɔ
	amɪnɪ
	amʊ

Appendix B: Gonja words analyzed

[+ATR]	[-ATR]
fiɪkaatoʔ	fiɪkaawɪ
fiɪkaadʒi	fiɪkaapɛ
fiɪkaaʃileʔ	fiɪkaajɔ
fiɪkaabiʃi	fiɪkaatɪgɪ
fiɪkaafeʔ	fiɪkaabʊsɪ
fiɪkaaʃu	fiɪkaatʃɛ
fiɪkaafoŋ	fiɪkaalɪgɪ
fiɪkaakosoʔ	fiɪkaatɔ
	fiɪkaakʊlɪ

	fiɪkaasɪga
	fiɪkaatɛ
	fiɪkaagɪsɪ
	fiɪkaapɪtɪ
	fiɪkaalʊlɔ