THE EPENTHETIC VOWEL QUALITY IN DAGBANI LOANS: A FEATURE GEOMETRY ACCOUNT

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Abstract: This paper explores the epenthetic vowel quality in Dagbani loanwords adapted from English and Arabic within the Feature Geometry (FG) model of Clements & Hume (1995). The findings reveal that vowel epenthesis plays a pivotal role as a syllable repair strategy in Dagbani. Three distinct strategies, namely vowel harmony, local/consonantal assimilation, and default vowel epenthesis, were identified to account for the quality of epenthetic vowels in Dagbani loanwords. Default vowel insertion emerged as the primary strategy, with the insertion of the central high vowel /ɨ/ and the front high vowel /i/. Vowel harmony was employed when the intervening consonant was a liquid or dorsal, occurring in word-initial, word-medial, and word-final positions. Conversely, the consonantal assimilation strategy was applied primarily in word-final position. In the context of vowel harmony, only labial features were observed to harmonize, while the consonantal assimilation strategy entailed the spreading of both coronal (palato-alveolar) and labial features. Finally, a segmental representation is provided of the Dagbani place feature in borrowed words, in which both left-to-right and right-to-left feature spreading are attested

Keywords: epenthesis, vowel harmony, local assimilation, default epenthesis

1. Introduction

Dagbani has substantially borrowed from most languages, particularly English and other languages. As a result, these words undergo multiple repair processes such as vowel epenthesis and consonant deletion to conform to Dagbani phonotactics to become a permanent part of her vocabulary. Scholars such as Uffmann (2006) and Kenstowicz (2007) emphasize the fact that vowel epenthesis is the general strategy that can be used to cope with restricted syllable formations and resist consonant deletion. However, Yip (1987) indicates that target phonemes in the listener's mind influence the likelihood of consonant deletion. He points out that when adapting foreign words, the decision between vowel epenthesis and consonant deletion depends on the class and situation in which a phoneme occurs in a syllable structure. These patterns in loanword processing suggest that a salient segment will be maintained while a non-salient segment will be deleted (Bamisaye & Ojo 2015). The idea of loanword adaptation or nativization at the phonological level is governed by syllable well-formedness in the recipient language – when a word is loaned from one language to another, in most cases it violates some constraints of syllable wellformedness (Mwita 2009). Kenstowicz (2007) claims that loanwords are no longer just a minor phonological curiosity or nuisance and merit the serious attention of theoretical research. According to Davis (1993: 1), "loanwords are of interest to phonologists for at least two reasons". The fundamental reason loanwords are of concern to phonologists is due to how loanwords are produced and perceived in the recipient language, and the reason for the change in pronunciation is frequently because the borrowed word may have particular segments that are absent from the language that is receiving the loanword.

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2. Vowel epenthesis

As shown by Uffmann (2006), vowel epenthesis is one of the major repair strategies in loanword adaptation to satisfy constraints on phonotactics and syllable structure in the borrowing language. Hall (2011: 1576) also points out that "the function of the epenthetic vowel is to repair an input that does not match the structure of a language or to allow the syllabification of stray consonants". The phonotactic of a language determines the patterns of phonological elements which should be tolerated or not tolerated. The tolerated ones are allowed to function while structures that are not tolerated need to be repaired before they can be used in the language. In accounting for loanword epenthesis in Bangali loanwords, Karim (2009) claims that, the language disallows initial consonant clusters and many word-initial consonant clusters, and that loanwords are simplified according to these phonotactic. The typology of English source words adapted in a variety of languages is presented in Uffmann (2006), where the illicit structures are repaired to conform to the receiving languages' phonotactics.

(1)   Epenthetic vowels in loanwords
         Yoruba   kʹ[ɪ]laʹaˋs[i]   'class'
         Kikuyu   ng[i]rath[i]   'glass'
         Japanese   s[ɯ]toraik[ɯ]   'strike'
         Samoan   s[i]kaut[i]   'scout'
         Fijian   s[i]piinij[i]   'spinach'

                                                       (Uffmann 2006: 1080)

The illicit structures in English source words in the above data are repaired through vowel epenthesis. Both consonant clusters and syllabic coda in the loanwords are banned from surfacing in the phonotactics of the recipient languages.

However, while the motivation behind the vowel epenthesis in loanwords is explicitly understood as a syllable structure reason, the question that arises among the loanwords phonologies has to do with the quality of the epenthetic vowel, that is which vowel is then inserted? Languages behave differently regarding the vowels they epenthesized, even when they possess the same vowel system (Alelaiwi 2014). For instance, the back high vowel [ɯ] is usually inserted in Japanese words (Shinohara 1997, Katayama 1998). While the front high [i] is also perceived as a fixed/default quality in some languages, including that of Haya (Byarushengo 1976), Yoruba (Pulleyblank 1988) and Fijian (Kenstowicz 2007. Hall (2011: 1581) also argues that the quality of an epenthetic vowel may be influenced in one of two ways: "it is either a fixed/default quality (which may, of course, be subject to normal allophonic variation according to the language's phonology), or else the quality is determined by some part of the phonological context". Similar observations were made by Uffmann (2004, 2006), Rose & Demuth (2006) and Adomako (2008) where they identified default vowel insertion, consonantal assimilation, and harmonic assimilation as the factors that determine epenthetic vowel quality in the loanwords repair process. Consequently, three types of vowel epenthesis are realized in loanwords; that is, vowel copying epenthesis, consonantal assimilation, and fixed or default or predictable vowel epenthesis. Uffmann (2006) proposed three epenthetic vowel strategies in loanwords, as shown below:

(2)   Epenthesis strategies: autosegmental representation[1].

a.   F   b.   F   c.   F

V C (V)   V   C (V)   (V) C   V
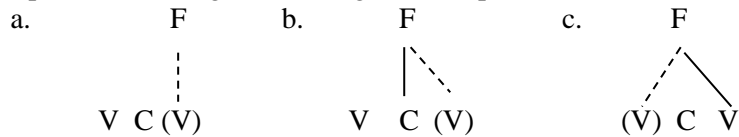
    a.   insertion of a default (feature insertion)
    b.   spreading of feature from neighboring consonant
    c.   vowel harmony (spreading of vocalic feature)

(Uffman 2006:1095)

The epenthetic vowel in (2) is inserted in three different ways, (2a) a new feature is usually inserted, which neither bears the place feature of the adjacent consonant nor the neighboring vowel. For (2b) the place feature specifies for the adjacent consonant spreads onto the epenthetic vowel slot. In (2c) the preceding vowel shares its place feature with the epenthetic vowel site.

The fixed or default inserted vowel has been looked at differently "depending on the researcher's theoretical affiliation" (Uffman 2006: 1080). On phonetics grounds, the default vowel has been perceived as "the unmarked or perceptually least salient vowel" (Repetti 2012: 168). The default vowel epenthesis has received remarkable attention in most phonologically-oriented approaches, including the work of Pulleyblank (1988), Abaglo & Archangeli (1989), Rose & Demuth (2006) and among others which suggests that the default vowel insertion is underspecified. The phonological studies of default epenthetic are also attributed to segmental markedness (Lombardi 2002, as cited in Uffmann 2006). This made the default epenthetic vowel difficult to completely account for the behavior of epenthetic vowels; thus, incorporating the use of other epenthetic strategies like vowel harmony and place spreading of the neighbouring sound (Uffmann 2006).

3. Methodology

Data was collected from two sources: primary and secondary. The primary data was obtained through direct interaction with the participants. The secondary data was obtained from English-Dagbani dictionary (Mahama 2010), the Dagbani-English dictionary (Mahama 2015), phonological and morphological adaptation of Dagbani loanwords (Iddrisu 2020).

Data collection for this study spanned from July to September 2022. The initial phase involved conducting Focus Group Discussions (FGDs) in four northern region towns: Tamale, Yendi, Mion, and Savulugu. In Tamale, two FGDs were held at Tamale College of Education, each with ten participants grouped into two sets of five. These discussions revolved around specific topics and lasted 1.5 to 2 hours. The conversations were recorded and later transcribed for analysis.

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[1] The three strategies can be used to account for epenthetic vowel quality in loanwords. Certain languages may vary or impose some restrictions on how the quality of the epenthetic is determined, especially for languages that possess unmarked vowels like /ɨ/, /ə/, /ɯ/, etc. to which Dagbani is no exception.

Similarly, in Yendi, a focus group discussion was conducted at the community center, involving ten participants. In the Mion and Savulugu districts, five participants from each location were selected, and FGDs were held at Sang Islamic Junior High School and Sevulugu Senior High School, respectively.

Furthermore, additional data was drawn from various sources, including the English-Dagbani dictionary (Mahama 2010), Dagbani-English dictionary (Mahama 2015), and the phonological and morphological adaptation of Dagbani loanwords (Iddrisu 2020). Numerous words were gathered during this period, resulting in 102 loanwords from the English-Dagbani and Dagbani-English dictionaries and 605 words derived from the phonological and morphological adaptation of Dagbani loanwords, totaling 707 loanwords from these sources.

4. Literature review

Previous studies on vowel quality argue that three strategies determine the quality of the epenthetic vowel in loanwords, (Uffmann 2006, Rose & Demuth 2006, Adomako 2008, Balan 2015). Uffmann notes that different phonological processes influence the epenthetic vowel quality in loanwords, namely, vowel harmony and local assimilation to the proceeding consonant. He adds that default vowel epenthesis will determine the epenthetic vowel quality if both vowel harmony and consonantal assimilation fail to spread its place feature onto the epenthetic vowel site. He states that, languages behave differently in terms of applying these strategies, and that some generalization could also be made possible to allow some common patterns to account for most languages. In discussing epenthetic vowels in Shona loanwords, Uffmann argues that the front high vowel [i] is frequently inserted followed by the back high vowel [u]. He opines that the front high vowel [i] is inserted when the proceeding consonant is coronal, whereas the back high vowel [u] is usually after a labial consonant and after dorsal consonant [i] is preferred as a default. He postulates that liquids are not actively involved in predicting the quality of the epenthetic vowel, therefore a whole range of vowels may occur after liquids. He argues further that there are some cases where the front vowel [i] is preferred as an epenthetic vowel even when the adjacent consonant is labial, i.e. when the preceding vowel is [i] and the labial consonant is obstruent /p, b, f, v/ – in such case vowel harmony will help to determine the epenthetic vowel quality over local/ consonantal assimilation. However, when the labial consonant is sonorant, like [m], the back/round vowel [u] is usually preferred in the epenthetic vowel site. Conversely, Uffmann postulates that [u] is also seen to be preferred in some environments when the intervening consonant is a stop preceding [u]. He states that the front high [i] is highly inserted, and it may be due to its default status in Shona.

In Sranan, Uffman noted that vowel harmony is the best predictor of the quality of the epenthetic vowel, unlike Shona where the consonantal assimilation strategy dominates the vowel harmony strategy. He maintains that the front vowel [i] is always inserted when the neighbouring vowel is the front vowel [i] or [e] whereas the back vowel [u] is inserted after a back vowel [u] or [o] this is exemplified below:

(3)   Epenthesis in Sranan
    a.   pres[i] 'place'   berg[i] 'hill
    b.   lont[u] 'round'   wort[u] 'word'
    c.   luk[u] 'look'   ud[u] 'wood'
    d.   big[i] 'big'   srib[i] 'sleep'
                                             (Uffmann 2006: 1089)

As seen in (3a-d) the place feature of the consonant does not spread onto the epenthetic vowel but rather the preceding vowels which harmonized its place feature onto the epenthetic site. Uffman argues that after the central low **[a]**, vowel harmony does not determine the epenthetic vowel quality as illustrated in (4) below.

(4)   Epenthesis after [a] in Sranan
    a.   laf[u] 'laugh'   grab[u] 'grab'
    b.   at[i] 'hot'   grass[i] 'glass, grass'
    c.   wak[a] 'walk'   tak[i] 'talk'
    d.   kar[i] 'call'   al[a] 'all'
                                             (Uffmann 2006: 1090)

In such cases, consonantal assimilation applies to determine the epenthetic vowel quality, but it has been realized that the dorsal and liquids do not participate in the assimilatory process. Uffmann argues that the general epenthetic vowel strategy for Shona is consonantal assimilation, and this language resorts to vowel harmony if consonantal assimilation fails to account for the epenthetic vowel quality. If both strategies fail then, the default insertion of [i] will be the last resort. Unlike Shona, where the general strategy is consonantal assimilation, in Sranan the general epenthetic strategy is vowel harmony; consonantal assimilation will only be applied if vowel harmony fails to account for the quality of the epenthetic vowel, and the last resort is the default insertion of [i].

    Uffmann (2006) also argues that a similar situation is found in Samoan. He writes that the front vowels [i] and [e] harmonize irrespective of the preceding consonant as in (5a-b) while the back vowels never harmonize. He maintains that, when the neighboring vowel is a non-front vowel, the place feature of the adjacent consonant or the default vowel insertion will be observed as a determinant of the epenthetic vowel quality.

(5)   Epenthetic vowels in Samoan
    a.   sip[i]   'jeep'   tik[i]   'teak'
    b.   pin[e]   'pin'   kalen[i]   'gallon'
    c.   satan[e]   'satan'   pelican[a] 'pelican
    d.   tulup[i]   'tulip'   pam[a]   'palm'
    e.   pam[u]   'pump,   mop[u]   'mop'
    f.   sos[i]   'sauce'   letus[i]   'lettuce'
    g.   falelog[i] 'furlong'   siok[a]   'chalk'
                                                 (Uffmann 2006: 1093)

As seen in (5), vowel harmony as an epenthetic strategy in Samoan is only possible when the neighboring vowel is a front vowel otherwise default or consonantal strategy will be applied. The default vowel insertion seems to dominate both consonantal and harmonic epenthetic strategies as it can apply after coronal, labial and dorsal consonants. Thus, the general epenthetic strategy in Samoan is default vowel insertion, contrary to what was observed in Shona and Sranan which have its general epenthetic strategy as consonantal and harmonic strategy respectively.

Rose & Demuth (2006) also examine the vowel epenthesis in loanwords adaptation in Sesotho. They argue that the direction and quality of the epenthetic vowel are easily predictable. They posit that the phonological processes play a crucial role in determining the strategy of the epenthetic vowel. They write that local assimilation helps to determine the epenthetic vowel quality at word-initial positions, which copies progressively onto the epenthetic vowel environment. Their findings suggest that both labial and coronal consonants spread their place features onto the epenthetic slot over the dorsal place feature which does not necessarily spread. However, they state that vowel harmony applies as an additional strategy from right-to-left when dorsal(velar) fails to spread features to the epenthetic site. This is similar to Shona which uses vowel harmony as a second resort when local assimilation fails to account for the quality of the epenthetic vowel. They argue that the default insertion of [ɑ] is the last resort when consonantal assimilation and vowel harmony fail to determine the epenthetic vowel quality.

Bălan (2015) examines vowel epenthesis in Japanese loanwords. Her findings suggest that vowel harmony, local assimilation and default vowel epenthesis can account for the epenthetic vowel quality in Japanese loanwords. She demonstrated that vowel harmony accounts for the epenthetic vowel quality when the neighboring vowel is a front vowel [i] and the intervening consonant is dorsal such as [k]. Bălan also states that local assimilation can predict the epenthetic vowel quality when the adjacent consonant is palatalized coronals such as [ʃ], [ʧ] and [ʤ], which triggers the insertion of a front high vowel [i]. She postulates that the default insertion of the placeless vowel [ɯ] is the dominant epenthetic strategy over local assimilation and vowel harmony strategies in Japanese loanwords, as well as the frequently inserted vowel to repair illicit structures in Japanese loans. She shows that the placeless vowel [ɯ] can be inserted after all consonants.

In his study of epenthetic vowels in Swahili loanwords, Harvey (2018) writes that consonantal assimilation, vowel harmony and default vowel insertion help to predict the inserted vowel quality in Swahili loanwords. He states that the place feature of the adjacent consonant invariably spreads onto the epenthetic vowel slot at word-final positions. He posits that the front vowel [i] is inserted after the coronal consonant, whereas [u] and [a] are inserted after labial and pharyngeal consonants respectively. He demonstrates that dorsal consonants do not spread their place feature, and that triggers the default insertion of the front high [i]. He further claims that vowel harmony also helps to determine the epenthetic quality at word-medial positions, that, [u] is inserted when the neighboring vowel is back/round, whereas [i] and [a] are inserted after the front and low vowels respectively.

Adomako (2008) claims that the place feature of the adjacent consonant usually helps to determine the epenthetic vowel quality in Akan loanwords. He posits that when the second consonant within the initial cluster is labial, a round/labial vowel is inserted into the epenthetic slot, as exemplified in (6):

(6)   Consonantal features spreading onto the epenthetic vowel in Akan loanwords

	English	Akan	Gloss
a.	/spiːd/	s[u]piːdi	'speed'
b.	/sməʊk/	s[u]moku	'smoke'
c.	/speə/	s[ʊ]pɛː	'spare'
d.	/spreɪ/	s[u]pre	'spray'
e.	/spɛktəklz/	s[ʊ]pɛːsɪ	'spectacles'

(Adomako 2008)

In (6), the place feature of the adjacent consonant plays a crucial role in determining the quality of the epenthetic vowel. The adjacent consonant possesses a labial place feature, which is typically copied from right-to-left onto the place of the epenthetic vowel. Similar observations were reported by Rose & Demuth (2006) in their study of Sesotho. However, their findings in Sesotho loanwords revealed that the direction of place feature copying (consonantal place) is left-to-right (progressively), which contrasts with the Akan pattern, where the copying usually occurs regressively onto the epenthetic site. Rose & Demuth (2006) further show that labial and coronal consonants have been perceived to spread over the dorsal. They indicate that labials such as /b/ or /p/ triggers the insertion of a round vowel while coronal consonants like /t/ or /d/ also trigger the insertion of a front vowel.

5. Theoretical framework

The present study adopts the Feature Geometry model of Clements & Hume (1995). Feature Geometry is a non-linear phonological representation of segmental features in structure hierarchy form. In phonological interpretation, feature geometry identifies that some groups of features frequently pattern together. As a result, feature geometry explicitly organizes sets of features under nodes, such that features that frequently pattern together are said to belong to a specific parent node. For instance, there is a laryngeal node that dominates the features that have to do with the larynx, i.e. spread glottis, constricted glottis, and voicing. Another node, which is a place node, dominates place features like labial, coronal and dorsal. The place features of consonants and vowels are presented on different tiers. The vowel place is a mother to a vocalic node which is dominated by consonant place node and a sister to the aperture.
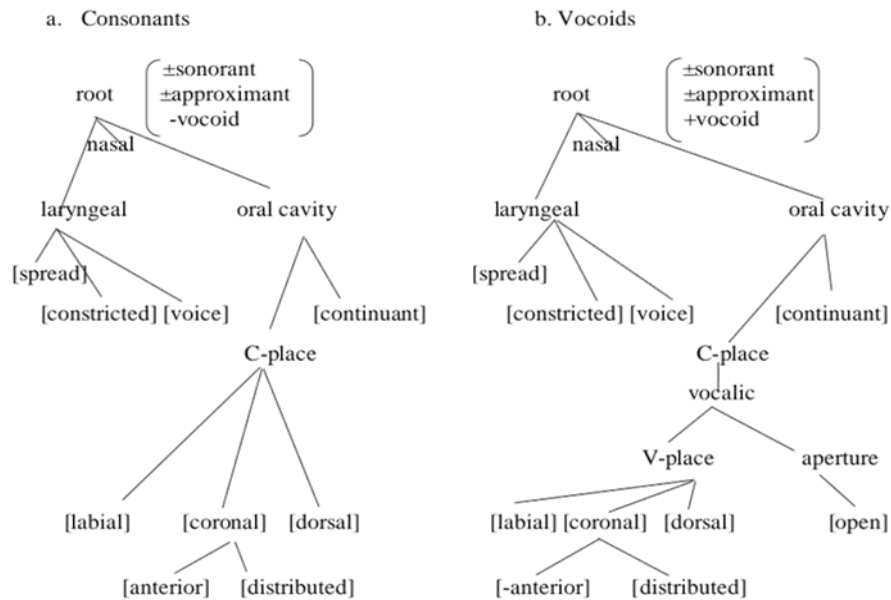
Figure 1. Clements & Hume's (1995) Feature Geometry tree

This study focuses on the place node, which is immediately dominated by the oral node. The place node dominates the vocalic node, within this node; the V-place (vowel place) and aperture node are immediately dominated by the vocalic node.
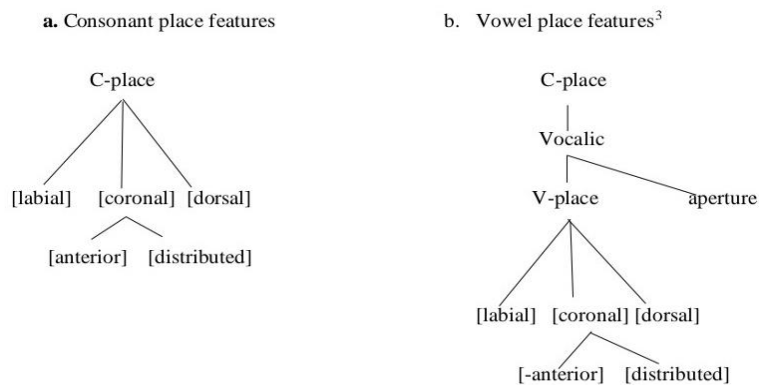
Figure 2. The Place node

In accordance with this model, vowels and consonants can be specified for the same place of articulation that is within the oral tract cavity. So, place features like labial, coronal and dorsal can be specified for vowel place features, as presented in Figure 2. Considering only the place node, the feature labial specifies for both labial consonants and back/rounded vowels, the place feature coronal specifies for both coronal consonants

and front vowels while the dorsal place feature specifies for both dorsal consonants and low vowels (see Clement & Hume 1995 for details). The central vowels satisfy none of the feature specifications above and should be regarded as phonologically placeless, (Clement & Hume 1995:24-25). Now, since this happens, vowels and consonants can bi-directional share their place features with each other, i.e. a vowel can be assimilated to a consonant, and it can also be assimilated by a consonant if there is the bearer of place features.

      Now, the feature spreading within this node (place node) will result in partial or incomplete assimilation, since the place features (except coronal) are terminal nodes – it is the place feature only that assimilates to the neighboring segment since the major (top-most) and other higher nodes are excluded.

```
root A   root B        or        root A   root B
     |___---                          ---___|
    place                                 place
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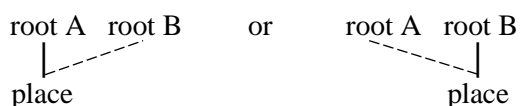
Figure 3. Place Feature spreading (from Clements & Hume 1995)

The place feature sharing those results in node A to node B is an instance of progressive assimilation (left-to-right) whereas in (b) the root node B triggers the feature sharing resulting in regressive place assimilation (right-to-left). The crucial aspect of this model is that feature sharing can occur from one tier to another tier without violating Goldsmith's No Crossing Condition (NCC).

```
C-place   C-place   C-place
   |         |         |
Vocalic      |      Vocalic
   |         |         |
V-place      |      V-place
   |_____|_____
[labial]
```
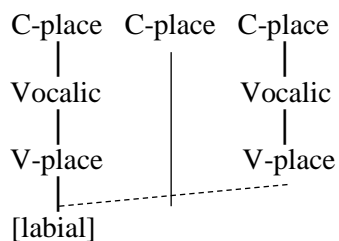
Figure 4. Spreading across intervening consonant (from Clements & Hume 1995)

The place feature of the vowel spread onto the neighboring vowel across the intervening consonant in Figure 6 above. Clements & Hume (1995) state that line-crossing must be allowed since they do not violate NCC. Thus, NCC would only be possible if the C-place node and V-place node are on the same tier. Ćavar (1997) states that the consonantal node in the representation of vowels is motivated by the fact that there are assimilations of the place of vowels across consonants but there are no assimilations of a place of consonants across vowels, and thus vowels have the consonantal node which prevents the linkage of consonantal features.

      Assuming Clements & Hume's (1995) model, since vowels and consonants can share the same place specification, place feature specified for the consonant can be linked to the adjacent vowel (Clements & Humes 1995), as exemplified below:

```
        V           C
        |           |
    (C-place)   C-place
        |           |
    (V-place)       |
        |_____|
                    
     [coronal]
```
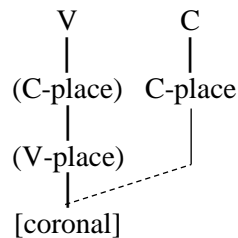
Figure 5. Spreading from consonant onto a vowel (from Clements & Hume 1995)

6. Vowel epenthesis in Dagbani loans

Vowel epenthesis is one of the major repair strategies in Dagbani loanwords adaptation. However, the language uses about five different vowels to solve illicit structures from occurring in Dagbani, as a result, the quality or type of vowel inserted to repair illicit structures in Dagbani is not straightforward since different vowels could be selected for epenthesis. Below in (7) I show how illicit forms are repaired through vowel epenthesis:

(7)   Illicit   Licit   Gloss
        a.   /bʊk/   [buku]   'book'
        a.   /kʌp/   [kɔpʊ]   'cup'
        b.   /dɪɛs/   [dɪre:sɨ]   'dress'

7. Quality of the epenthetic vowel

It has been observed that three strategies help to determine the epenthetic vowel shape or quality in Dagbani loanwords, namely: vowel harmony, consonantal/local assimilation and default vowel epenthesis.

7.1 Vowel harmony

Vowel harmony or copy epenthesis has been observed to determine the epenthetic vowel quality in several studies, including the work of Uffmann (2006), Rose & Demuth (2006), Adomako (2008), and Bălan (2015). It is where the place feature has been specified for the neighboring vowel harmonize onto the epenthetic slot. The current study has discovered that the presence of a vowel feature plays a role in predicting the quality of the inserted vowel in Dagbani loanwords. The study also identified specific limitations in terms of positions and copying direction, as well as the influence of the neighboring vowel's place feature. In the upcoming sections, I provide generalizations regarding the quality of the epenthetic vowel observed in Dagbani loanwords derived from English and Arabic.

7.1.1 Epenthesis of [u] or [ʊ] in word-initial clusters

When the intervening consonant is liquid followed by a rounded vowel, a round/labial vowel is copied from right onto the epenthetic vowel site at word-initial clusters.

(8)		English source word	Loan	Gloss
	a.	/blu:/	[bulu:]	'blue'
	b.	/glu:/	[gulu:]	'glue'
	c.	/drɔ:ɪŋ/	[dʊrɔ: ɪŋ]	'drawing'
	d.	/kləʊs/	[kʊlo:sɨ]	'close'

The results in (8) demonstrate that the place feature of the neighboring vowel is copied to the epenthetic site in word-initial positions. Consequently, the epenthetic vowel inherits the place feature specified for the neighbor. Notably, the neighboring vowel is rounded, and this place feature is copied across the intervening liquid. The process of copying occurs from right-to-left, which is also referred to as progressive assimilation.

7.1.2 Epenthesis of [ʊ] or [o] in word-medial clusters

When the intervening consonant is velar or liquid followed by a rounded vowel, a round/labial vowel is copied right into the epenthetic vowel site at word-medial clusters.

(9)		English source word	Loan	Gloss
	a.	/kəʊlpɔt/	[kurofo:tʊ]	'coal pot'
	b.	/əkrɔs/	[akʊro:sɨ]	'across'

As can seen from (9), when the intervening consonant is velar or liquid followed by a labial vowel, a round vowel is copied from the right into the epenthetic vowel site in word-medial clusters.

7.1.3 Epenthesis of [u] or [ʊ] in word-final position

When the intervening consonant is velar or liquid or non-bearer of place feature preceded by a rounded vowel, a round/labial vowel is copied from left onto the epenthetic vowel site at word-final position.

(10)		English source word	Loan	Gloss
	a.	/bʊk/	[buku]	'book'
	b.	/sku:l/	[ʃikʊrʊ]	'school'
	c.	/kʊk/	[kuku]	'cook
	d.	/stɔ:/	[ʃitɔʔu]	'store
	e.	/klɔk/	[kʊlɔkʊ]	'clock'

The examples under (10) shows that, the epenthetic vowel quality is determined by the place feature of the neighboring (labial) vowel. The place feature that is associated with the neighbor spreads onto the epenthetic vowel site. The spreading occurs progressively across the intervening consonants onto the inserted vowel environment. The direction of the copying differs from what was seen earlier, in word-initial and word-medial positions, where the feature copying was invariably from the right.

7.1.4 Labial spreading with intervening coronal consonants

When the intervening consonant is coronal, preceded/followed by a round/labial vowel, place feature harmonizing of the labial feature is unpredictable.

(11)   English source word   Loan   Gloss
   a.   /ju:z/   [ju:sɨ] *[ju:su]   'use'
   b.   /vɔt   [vo:tɨ] *[vo:tʊ]   'vote'
   c.   /kəʊpɔt/   [kurʊfo:tʊ]   'coal pot'
   d.   /kɔ:t/   [ko:tʊ]   'court'

The quality of the epenthetic vowel is unpredictable based on the place feature of the neighbor. In (11a-d), the insertion of a labial place feature onto the epenthetic vowel site would render it ungrammatical. Conversely, (11c-d) opts for labial place feature insertion for unknown reasons. The coronals sometimes block feature spreading crossing it.

7.1.5 Epenthesis of a low vowel after [a] in word-medial clusters

When the intervening consonant is preceded by a low vowel [a], the low vowel is always copied either from left or right onto the epenthetic vowel site in word-initial and word-medial clusters in Arabic source words.
   Left-to-right spreading of the central low vowel [a] is illustrated below:

(12)   Arabic source word   Loan   Gloss
   a.   /nasˀr/   [nasara]   'victory'
   b.   /waqt/   [waʔatɨ]   'time'
   c.   /maɣrib/   [magarɨbɨ]   '4th daily prayer'

The following are examples of right-to-left spreading of the central low vowel [a]:

(13)   Arabic and Twi   Loan   Gloss
             source word
   a.   /swalaat/   [sala:tʊ]   'prayer'
   b.   /sadaqah/   [sara]   'charity'
   c.   /nkrakra/   [karakara]   'light tomato soup'
   d.   /akra/   [akara]   'Accra'

The data in (12) and (13) show that, the low vowel feature from the neighboring vowel is copied onto the epenthetic environment[2]. The feature spreading can either be progressive or regressive across the intervening consonant onto the epenthetic vowel slot in word-initial and word-medial clusters.

7.2 Local assimilation

Consonantal assimilation has been observed to determine the epenthetic vowel quality. It is where the adjacent consonant spreads its place feature onto the epenthetic vowel slot. The direction of the spreading could be progressive (left-right) or regressive (right-left) or even both occurring in a particular language. However, the place feature that is been copied may vary or be determined by a particular context as well as the frequency of the feature being copied, Adomako (2008) argues that labial place features are frequently copied followed by coronal place and the dorsal place in Akan loanwords. This means that, he dorsal place is the least marked place feature, followed by coronal and the labial being the most marked place features, as presented in Figure 9.

(14)   Labial >> Coronal >> Dorsal

(Adomako 2008)

Next, I focus on how consonantal place feature spreading helps to predict the epenthetic vowel quality in Dagbani source words incorporated from English and Arabic.

7.2.1 Epenthesis of a rounded vowel after labial consonants

When the final illicit consonant is labial, a rounded/labial vowel is always inserted into the epenthetic vowel site at word-final positions in English sourced words.

(15)		English source word	Loan	Gloss
	a.	/kʌp/	[kɔpʊ]	'cup'
	b.	/bʌlb/	[bolɨfʊ]	'bulb'
	c.	/braɪb/	[bɨra:pʊ]	'bribe'
	d.	/tju:b/	[tupʊ]	'tube'
	e.	/sɪv/	[si:fʊ]	'sieve'

As shown in (15), the quality of the epenthetic vowel is always determined by the place feature of the adjacent consonant. As can be seen, the place feature of the adjacent consonant is labial, which spreads progressively to prevent the ill forms from surfacing in the recipient language.

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[2] This generalization is based on Dagbani loanwords from Arabic only. It has not been attested whether dorsal/low vowels do spread in English loanwords.

7.2.2 Epenthesis of a front vowel after palato-alveolar affricates

According to Mattingley et al. (2019), the palato-alveolar affricates [tʃ] and [dʒ] are often followed by the insertion of the front vowel [i]. They state that adding the front vowel [i], which shares an articulation point with these consonants, is phonetically natural. The same patterns can be seen in the repair of Dagbani nativized words, where the insertion of the front high vowel [i] occurs after [tʃ] and [dʒ], as exemplified in (16):

(16)		English source word	Loan	Gloss
	a.	/frɪdʒ	[firidʒi]	'fridge'
	b.	/tʃɑ:dʒ/	[ʧa:dʒi]	'fare'
	c.	/gæŋ/	[gandʒi]	'a gang'
	d.	/ʧeʧ/	[ʧe:ʧi]	'church'
	e.	/kɔlɪdʒ/	[kolɛdʒi]	'college'

From the above, the adjacent palatal-coronal consonants spread their place features onto the epenthetic vowel site. It should be borne out that, the plane coronal consonants [t, d, s, z, n etc.] do not involve such kind of feature spreading, it is only the palatal-coronal that spreads its place features. Additionally, evidence can be adduced from Arabic loanwords, where consonant place moves to palatal place before front vowels, resulting in palatalization, as shown below:

(17)		Arabic source word[3]	Loan	Gloss
	a.	/ma:lik	[maliʧi] *malik[i]	'king'
	b.	/mulk	[mʊlʧi] *mʊlk[i]	'subjects'
	c.	/muna:fiq/	[mʊna:fit[i] *mʊna:fik[i]	'hypocrite'
	d.	/ʔarrizq/	[arizɨʧi] *arizɨtk[i]	'wealth'

7.3 Default epenthetic vowels

Optimality Theory postulates a unique representation of default vowel epenthesis. This process involves the insertion of new phonological material that is not present in the underlying form. However, Lombardi (2002) conducted a quantitative typological survey, examining the epenthetic vowel quality in numerous languages worldwide. According to her findings, if a language's vowel system includes an unmarked vowel, that unmarked vowel tends to be used as a general epenthetic strategy. In cases where the unmarked vowel is absent, the language will select the least marked vowel available. Based on her observations, Lombardi (2002) proposed a markedness hierarchy in which back vowels are less marked than front vowels, high vowels are less marked than low vowels, and unrounded vowels are less marked than rounded vowels:

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[3] The Arabic word-final consonants are adapted as palatal-coronal before a front/coronal vowel. This shows that there is a place feature interaction between palatal consonants and front/coronal (see also Clements & Hume 1995).

(18)   a.   Back vowels are less marked than front vowels: *Front > *Back
        b.   Mid vowels are marked: *Mid
        c.   Round vowels are marked: *[+round] >> *[−round]

<div align="right">(Lombardi 2002)</div>

It depends on the vowels that you have in your language vowel inventory that will show how it will be positioned. And, Dagbani has /ɨ/ unmarked, the unmarked vowels in phonology have been treated to be phonological placeless because they do not make any contrast with respect to the place feature spreading.

7.3.1 Epenthesis of [ɨ] after non-final labial consonants

When the preceding or the following vowel is unrounded/non-labial vowel, the central placeless vowel [ɨ] is always inserted as a default after labial consonants in non-word-final position in English source words.

(19)   English source word   Loan   Gloss
        a.   /bleɪd/   [bɨle: dɨ]   'blade'
        b.   /braɪb/   [bɨra:pʊ]   'bribe'
        c.   /breɪk/   lbɨre:tʃ   'brake'
        d.   /presŋaɪɔn/   [pɨrɛsa:jɔn]   'pressing iron'
        e.   /əsɛmblimæn/   [asambɨlimani]   'assemblyman'

The epenthetic vowel that is inserted to repair illicit structure is the placeless vowel [ɨ] in English source words. The motivation behind the insertion of this vowel after labial consonants is determined when the preceding or the following vowel is unrounded or labial vowel in non-word final position only.

7.3.2 No epenthesis of [ɨ] after word-final labial consonants

The insertion of the default [ɨ]is prohibited after labial consonants in word-final position. In this environment, the epenthetic vowel is preferred to copy the place feature of the adjacent consonant.

(20)   English source word   Loan   Gloss
        a.   /bʌlb/   [bolɨfʊ] *[bolifɨ]   'bulb'
        b.   /braɪb/   [bɨra:pʊ] *[bɨra:pɨ]   'bribe
        c.   /paɪp/   [pa:pʊ] *[pa:pɨ]   'pipe'

7.3.3 Epenthesis of [ɨ] after coronal consonants

When the adjacent consonant is coronal (non-palatal), the default vowel [ɨ] ccupies the epenthetic slot.

(21)   English source word   Loan   Gloss
   a.   /bleɪd/   [bɨle:dɨ]   'blade'
   b.   /dɹɛs/   [dɨre:sɨ]   'dress'
   c.   /fɔrɪst/   [fo:re:sɨ]   'forest'
   d.   /pɪstəl/   [pi:sɨlɨ]   "pistol'
   e.   /mɪlk/   [mɨlɪtʃɪ]   "milk"

The epenthetic vowel to repair illicit structures is invariably the central high [ɨ] occurring after coronal consonants in both English and Arabic source words. The only exceptions observed so far is the English source words [sku:l] and [belt]:

(22)   English source word   Loan   Gloss
         /sku:l/   [ʃi]kʊrʊ] *[sɨkuru]   'school'
         /belt/   [balatɨ]   *[balɨtɨ]   'belt'

7.3.4 Epenthesis of [ɨ] or [i] after dorsal consonants

When the adjacent consonant is dorsal, preceded or followed by an unrounded vowel, default [ɨ] or [i] occupies the epenthetic slot, as in (23) and (24), respectively:

(23)   English source word   Loan   Gloss
   a.   /gɹi:s/   [gɨri:sɨ]   'grease'
   b.   /grævəl/   [gɨrabʊlɨ]   'gravel'
   c.   /pɑ:k/   [pa:kɨ]   'park'
(24)   English source word   Loan   Gloss
   a.   /bæg/   [ba:dʒi]   'bag'
   b.   /brɪks/   [bɨlɪtʃisɨ]   'bricks'
   c.   /gæŋ/   [gandʒi]   'a gang'
   d.   /mɪlk/   [mɨlɨtʃɪ]   'milk'

The inserted vowel quality is default [ɨ] or [i] after a dorsal consonant. In (23) the central high placeless vowel [ɨ] is inserted after the dorsal, while in (24) the front high vowel /i/ is inserted after the dorsal.

8. Feature Geometry analysis

This section provides a theoretical analysis of the phenomena of vowel epenthesis in Dagbani loanwords. I attempt to make segmental representations of the Dagbani place feature as observed in the adaptation processes using the Feature Geometry model of Clements & Hume (1995).

8.1 Place features of consonants and vocoids

Clements & Hume (1995) suggested a natural class of both consonants and vowels with respect to oral track features.

(25)   a.   [labial]: labial consonants; rounded or labialized vocoids
       b.   [coronal]: coronal consonants; front vocoids
       c.   [dorsal]: dorsal consonants; back vocoids

Based on the place features in (25) above, I define Dagbani vowels and consonants in Tables (1) and (2):

Table1. Feature Geometry definition of Dagbani vowels

	Front			Central					Back/rounded
	i	e	ɛ	ɨ	a	u	ʊ	o	ɔ
[Coronal]	●	●	●						
[Labial]						●	●	●	●
[Dorsal]						●	●	●	●

The front vowels [i, e, ɛ] are specified for coronal place features, the rounded/back vowels [u,ʊ,o,ɔ] are specified for labial and dorsal place features while the central vowels [ɨ, a] are considered placeless.

Table2: Feature Geometry definition of Dagbani consonants

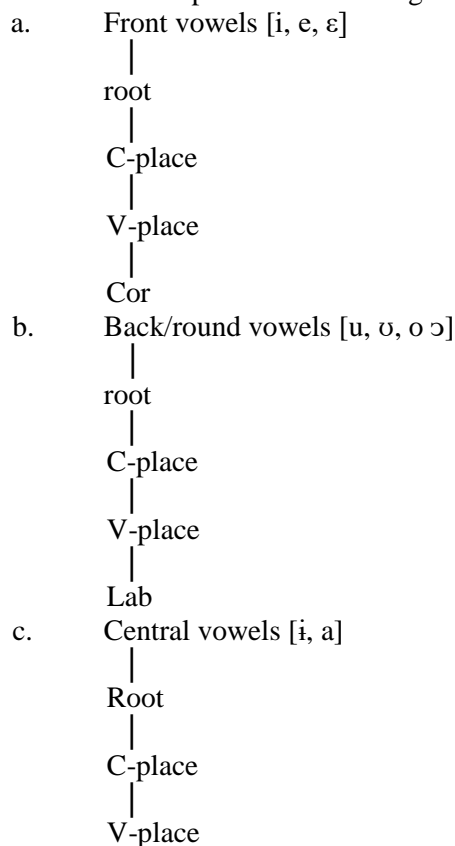| [Labial]		[Coronal]		[Dorsal]	
p b m f v	[tp] [db] [nm]	t d n ɲ s z [ʃ] [ʒ] ʧ ʤ l [ɾ]	kp gb ŋm w j	k ɡ ŋ [x]	[ʔ] [h]

Given the above representation of the Dagbani consonants chart, I provide a segmental representation of the Dagbani place feature structure, focusing on three place dimensions; labiality, coronality and dorsality. Segments which do not fall into any of the place dimensions are considered not to be specified for place features; this is discussed in detail in upcoming sections.

8.2 Place feature representation of Dagbani vowels and consonants

According to Rice & Avery (1993, as cited in Rose & Demuth 2006) features must be integrated into segmental representations only if they serve to mark a contrast in the language. "In cases where multiple systems of underspecification might be available to the language learner, phonological or morpho-phonemic alternations will provide the evidence needed to posit the correct representations for the target language", (Rose & Demuth 2006: 1120). For the place features of Dagbani vowels, [i, e, ɛ] contrast with [u, ʊ, o, ɔ] with regards to their place feature dimension, i.e. frontness (coronality) and backness (labiality) contrast. While [ɨ,a] does not participate in place interaction, hence does not have a place contrast. Below, I posit a segmental representation of Dagbani place features of vowels and consonants, presented in (26) and (27), respectively.

(26)   Place feature representation of Dagbani vowels
         a.   Front vowels [i, e, ɛ]
                   |
                   root
                   |
                   C-place
                   |
                   V-place
                   |
                   Cor
         b.   Back/round vowels [u, ʊ, o ɔ]
                   |
                   root
                   |
                   C-place
                   |
                   V-place
                   |
                   Lab
         c.   Central vowels [ɨ, a]
                   |
                   Root
                   |
                   C-place
                   |
                   V-place

The segmental representation of Dagbani vowels in (26) shows exactly how the epenthetic vowel quality will be manifested through the strategies already discussed above. However, I specify the front vowel of Dagbani for the coronal place feature and the back/round vowels for the labial place features. The central vowels are treated as phonological placeless, as they do not make any contrast between frontness and backness features. The feature dorsal has not been specified for any, as it would result in redundancy since it is the mother node of backness and height features (Clements & Hume 1995, Halle 1995).

(27)   Place feature representation of Dagbani consonants
        a.   Labials [p, b, f, v, m]
                        |
                      root
                        |
                    C-place
                        |
                    V-place
                        |
                      Lab
        b.   Coronals (only palato-alveolar affricates)
                        |
                      root
                        |
                    C-place
                        |
                    V-place
                        |
                      Cor
        c.   Dorsals [k, g, ŋ]
                        |
                      root
                        |
                    C-place
                        |
                    V-place
                        |
                      Dor
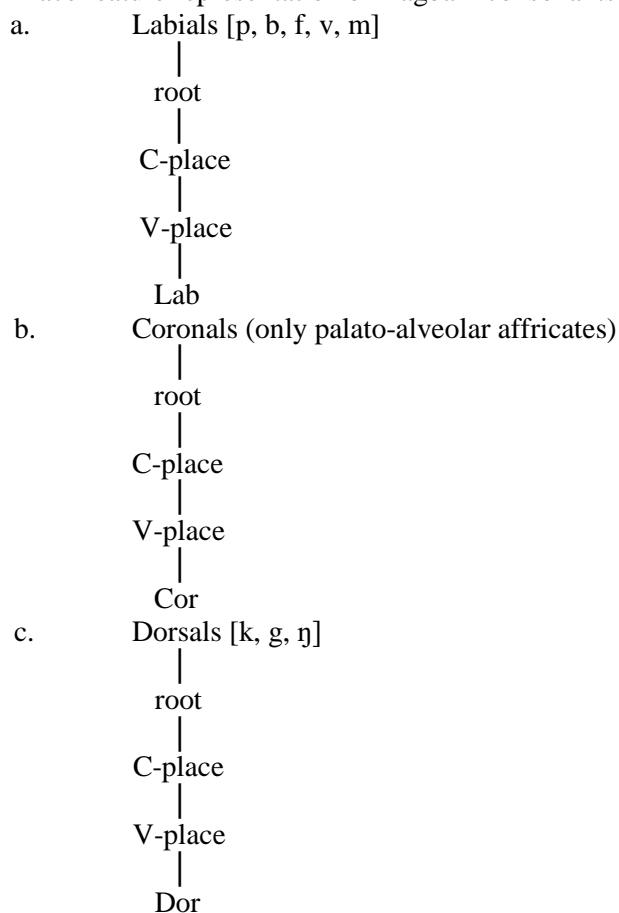
The representation in (27) shows how to place features of Dagbani consonants can be incorporated into a segmental representation, the labial consonants could be grouped as possessors of place feature of labiality, and can inherently contribute to place feature spreading as observed in (27a). In (27b), the only coronal category that is attested in the data to contribute to place spreading is the palato-alveolar affricates [ʧ, ʤ]. For liquids, their phonetic coronality has been treated as phonologically placeless, and does not necessarily contribute to place spreading (Rose & Demuth 2006, Adomako 2008). The
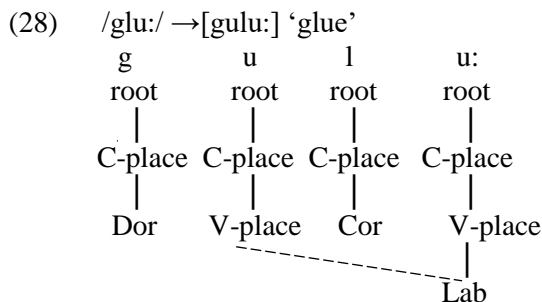
dorsal place feature in (27c) is specified for velar consonants, though velars are been attributed not to spreads as observed in the data above, where both coronal (palato-alveolar affricates [ʧ, ʤ]) and labial mostly spread at the expense of velar, similar observations were made by Uffmann (2006), Rose & Demuth (2006) and Adamoko (2008), where other place features always spread except dorsal (velars).

8.3 Vocalic place feature spreading

Vocalic place feature spreading occurs when the neighboring vowel harmonizes its place feature onto the epenthetic vowel environment. This type of spreading can be either progressive or regressive, linking the place feature from one V-place node to another V-place node across the intervening consonant. The data below illustrate feature spreading, where vowel harmony determines the quality of the epenthetic vowel.
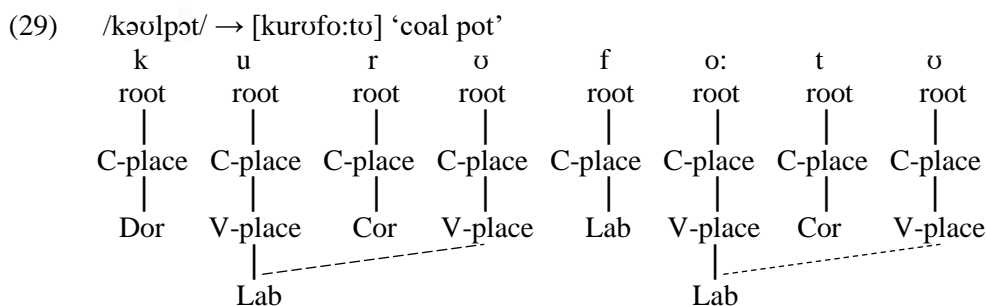
8.3.1 Labial place feature spreading in word-initial clusters

The labial place feature of the neighboring vowel spreads across the intervening liquid onto the epenthetic vowel this kind of spreading is right-to-left spreading also known as regressive place assimilation.

(28) /glu:/ →[gulu:] 'glue'

```
       g           u           l           u:
      root        root        root        root
       |           |           |           |
    C-place     C-place     C-place     C-place
       |           |           |           |
      Dor       V-place      Cor        V-place
                   └─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─┘
                                        Lab
```

8.3.2 Labial vowel spreading in word-medial clusters

The labial place feature specified for the neighboring vowel spreads regressively across the intervening liquid onto the epenthetic vowel.

(29) /kəʊlpɔt/ → [kurʊfo:tʊ] 'coal pot'

```
     k        u        r        ʊ        f        o:       t        ʊ
    root     root     root     root     root     root     root     root
     |        |        |        |        |        |        |        |
   C-place  C-place  C-place  C-place  C-place  C-place  C-place  C-place
     |        |        |        |        |        |        |        |
    Dor    V-place    Cor    V-place    Lab    V-place    Cor    V-place
              └─ ─ ─ ─ ─ ─ ─ ─ ┘                  └─ ─ ─ ─ ─ ─ ─ ─ ─ ┘
             Lab                                  Lab
```

8.3.3 Low vowel [a] spreading in word-medial clusters

In the representation below the central low vowel [a][4] spreads progressively across the intervening coronal consonant **/s/** onto the epenthetic vowel site in the Arabic source word:

(30)   /nasr/ → [nasara] 'victory'

```
      n         a         s         a         r         a
    root      root      root      root      root      root
     |         |         |         |         |         |
  C-place   C-place   C-place   C-place   C-place   C-place
     |         |         |         |         |         |
    Cor     V-place    Cor     V-place    Cor     V-place
               |_____|
```
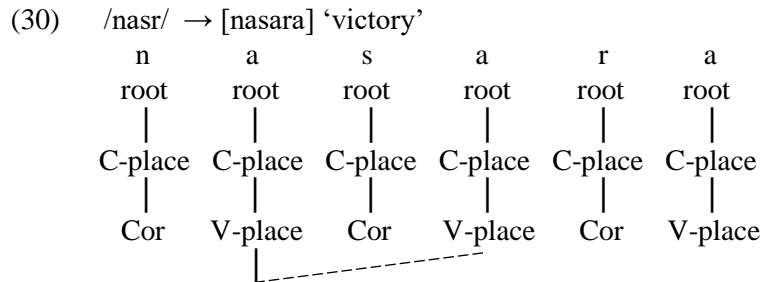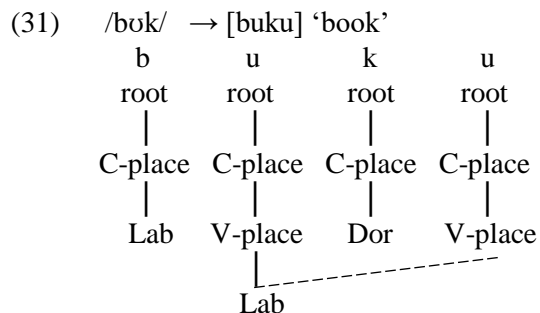
8.3.4 Labial place feature spreading in word-final position

The labial place feature of the neighboring vowel spreads progressively across the intervening dorsal into the epenthetic vowel site in word-final position.

(31)   /bʊk/ → [buku] 'book'

```
      b         u         k         u
    root      root      root      root
     |         |         |         |
  C-place   C-place   C-place   C-place
     |         |         |         |
    Lab     V-place    Dor     V-place
               |_____|
              Lab
```
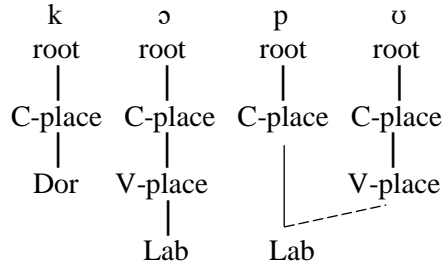
8.4 Consonant place feature spreading

The epenthetic strategies observed in the analyzed Dagbani loanwords show that consonantal place features play a crucial role in determining the quality of the inserted vowel. This strategy involves the spreading of features from the consonantal place node of a neighboring to the vowel place node, as illustrated below.

8.4.1 Labial consonant spreading

The adjacent labial place feature spreads progressively its labial feature onto the epenthetic vowel slot in word-final positions.

---

[4] The central low [a] is considered not to be specified for any place feature, hence I presented it as bare.
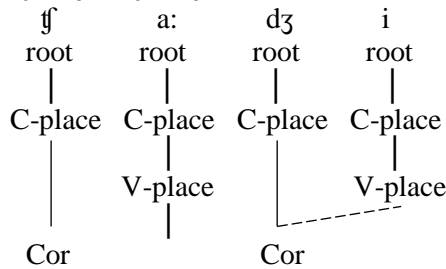
(32)   /kʌp/ → [kɔpʊ] 'cup'

```
          k           ɔ           p           ʊ
        root        root        root        root
          |           |           |           |
       C-place     C-place     C-place     C-place
          |           |           |            |
         Dor       V-place                  V-place
                      |                        
                     Lab         Lab
```

8.4.2 Coronal (palato-alveolar affricate) [dʒ] place feature spreading

The palato-alveolar affricate (coronal) spreads progressively its coronal place feature onto the epenthetic environment.
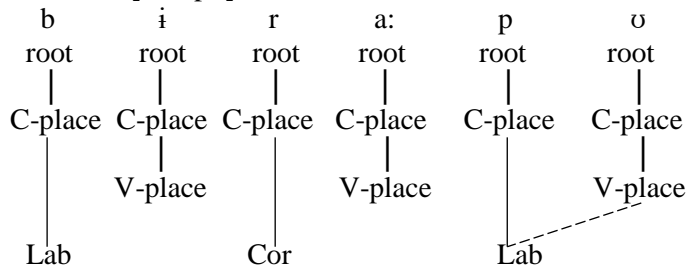
(33)   /tʃɑːdʒ/→[tʃɑːdʒi] 'fare'

```
          tʃ          aː          dʒ          i
        root        root        root        root
          |           |           |           |
       C-place     C-place     C-place     C-place
          |           |           |            |
                   V-place                  V-place
                      |                        
         Cor                     Cor
```

8.4.3 Default vowel epenthesis

The default vowel insertion involves adding a vowel that lacks the place feature of both the neighboring vowel and the adjacent consonant. This default vowel insertion prevents place feature spreading, as it requires the introduction of a distinctive place feature that is not already present. The placeless vowel [ɨ] serves as the primary default vowel in the language. In the Feature Geometry representation there are no linkage or association lines between the default vowel and the relevant segments since the default vowel is placeless. However, it should be noted that the placeless vowel [ɨ] is presented as a bare vowel, i.e it lacks a place feature.

(34)   /braɪb/ → [bɨraːpʊ] 'bribe'

```
          b           ɨ           r          aː           p           ʊ
        root        root        root        root        root        root
          |           |           |           |           |           |
       C-place     C-place     C-place     C-place     C-place     C-place
          |           |           |           |           |           |
                   V-place                 V-place                 V-place
                                                                     
         Lab                     Cor                     Lab
```

 As can be seen the placeless vowel **[ɨ]** is inserted within labial-liquid clusters to repair illicit structures in word-initial positions. The place feature linkage of the associate line is devoid as [ɨ] does not have a place feature.

9. Conclusions

The intended goal of this paper was to examine the quality of the epenthetic vowels in Dagbani loanwords. First, it looked at the strategies that determine the epenthetic vowel quality. It revealed that three strategies determine the epenthetic vowel quality in Dagbani loanwords; namely vowel harmony, local/consonantal assimilation and default vowel epenthesis. The vowel harmony strategy is possible when the neighboring vowel is a back/round vowel and the intervening consonant is dorsal or liquid – this occurs at the word-initial cluster, word-medial cluster and word-final positions. However, the consonantal strategy occurs at the word-final positions after labial and coronal consonants (only palato-alvealor) – i.e. [u] or [ʊ] is inserted after labial consonants while [i] is inserted after [tʃ], [dʒ]. The last strategy is the default vowel epenthesis – whereby the vowels [ɨ], [i], [u] are inserted.

For a formal analysis of the data derived from loanwords in Dagbani, a feature-geometrical representation was provided of the place feature in borrowed words. It was shown that the vowel's labial place feature always spreads across the intervening consonant and onto another V-place node, and that both progressive and regressive spreading are recognized. The local assimilation occurs from C-place node to V-place node. Feature spreading from a C-place node to a V-place node is unidirectional as observed from the representations, meaning that only the left-to-right (progressive) spreading is attested.

The default vowel epenthesis is seen as a general epenthetic strategy in Dagbani loanwords as it can occur after all the consonants in the inventory like that of Japanese, which opts for default epenthesis over vowel harmony and consonantal strategy as its dominant epenthetic strategy. Lombardi (2002) predicted that languages that possess unmarked vowels like [ɨ] or [ɯ] are going to insert them in most contexts, and Dagbani and Japanese have [ɨ] and [ɯ] respectively in their vowel inventory. However, other languages that lack such vowels either opt for vowel harmony or consonantal strategy as thier general strategy for epenthesis. For instance, in Shona, Sesotho and Akan utilize the consonantal assimilation strategy as a general strategy for epenthesis. Likewise, Sranan resorts to vowel harmony as its general strategy for epenthesis

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