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SYLLABIFICATION IN OPTIMALITY THEORY

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ABSTRACT: *This paper examined syllabification in the Sokoto dialect of Fulfulde within the framework of Optimality Theory. The theory employed constraint-based rather than rule-based notations in the analysis of the grammar of languages. This study focused on the Sokoto dialect of Fulfulde in view of the number of dialects of the language spoken across West Africa. Using field-based data, the analysis revealed the salient syllabification requirements of Fulfulde. Findings showed that the syllables of the Sokoto dialect of Fulfulde require onsets and nuclei as obligatory elements. Syllable onsets in the dialect are maximally composed of a single consonant as complex onsets are prohibited. Codas are optional and may be simple or complex. A restriction placed on coda consonants is that except half of geminates, only sonorants are allowed, although in word-final positions, [ŋ], a sonorant, is not attested. These outcomes demonstrated the extent of conformity of Sokoto Fulfulde syllables with the markedness constraints governing syllable structure and the Syllable Contact Law. Further findings indicated that although syllabification in languages is grounded in the sonority of segments vis-à-vis the restrictions that languages place on phoneme combinations, the sonority scale, as presently designed does not adequately handle syllabification in this dialect; calling for an all-inclusive sonority scale.*

KEYWORDS: Syllabification, Optimality theory, Syllable contact, Fulfulde language, Sokoto dialect.

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INTRODUCTION

This paper examines syllabification in Optimality Theory, using Fulfulde language as an example. The Fulfulde language is spoken by the Fulani people mainly in the western part of Africa. Literature on the language shows that it is also called Fulani in English or Pulaar, Pulo, Fulɓe (Paradis, 1992). The language is also known as Peul, Pul and Pular (McIntosh, 1984). As wide-ranging as the name of the language is, so is the opinion of scholars about its origin.

Taylor (1953), appealing to Biblical accounts proposes that the language comes from the Hamitic Family. McIntosh (1984) on her part, concludes that the language belongs to the West-Atlantic branch of the Niger-Congo family. Ruhlen (1975) in Paradis (1992) and Westermann and Bryan (1970) contend that Fulfulde is a Kordofanian language belonging to the Niger-Congo group of the West-Atlantic subgroup. Harrison et al. (2012) also describe Fulfulde as a member of the Atlantic branch of the Niger-Congo family. Another account, based on lexicostatistics, classifies the language as a member of the North-Atlantic language family (Segerer, 2002; Segerer, 2010; Fisher, 2015; Segerer & Pozdniakov, 2016). This view correlates with the description in WALS online (Dryer & Haspelmath, 2013) that Fulfulde belongs to the Northern Atlantic genus of the Niger-Congo family.

Optimality Theory

The cumbersome nature of rule-based approaches in the description of natural languages informed the foundation and the response to the premise of Optimality Theory (Prince & Smolensky, 1993; McCarthy & Prince, 1993; Prince & Smolensky, 2004). It was observed that "universal constraints alone, rather than a mix of constraints and rules, account for linguistic phenomena" (Archangeli, 1999, p. 532). Grammar in Optimality Theory, Archangeli (1999) explains, is understood as a system of hierarchically ranked constraints with respect to each other. These constraints allow violations to occur in view of cross-linguistic variations. The set of hierarchical but violable constraints provide a means by which inputs are correlated with outputs by means of an evaluation mechanism, summed up in Archangeli (1999, p. 533) thus:

At the heart of OT is the idea of universal constraints, which are nevertheless violable. By being universal, the constraints themselves provide an explicit means of characterising the cross-linguistic similarities that exist. By being violable, there is a means of expressing language variation: the degrees of violation tolerated for each constraint are unique to each language. OT proposes a single means of expressing which constraints are violable, namely constraint ranking-violations of lower-ranked constraints are tolerated in order to satisfy higher-ranked constraints.

The "architecture" of Optimality Theory, reproduced in Figure 1 from Archangeli (1999, p.534) indicates that GEN (as defined below), is a constituent of the grammar which produces possible output candidates in relation to the input and presents them to EVAL (defined below) which in turn, evaluates them. The evaluation proceeds from a hierarchy of ranked but violable constraints. EVAL eventually selects the output with the least or no violation as the optimal candidate.

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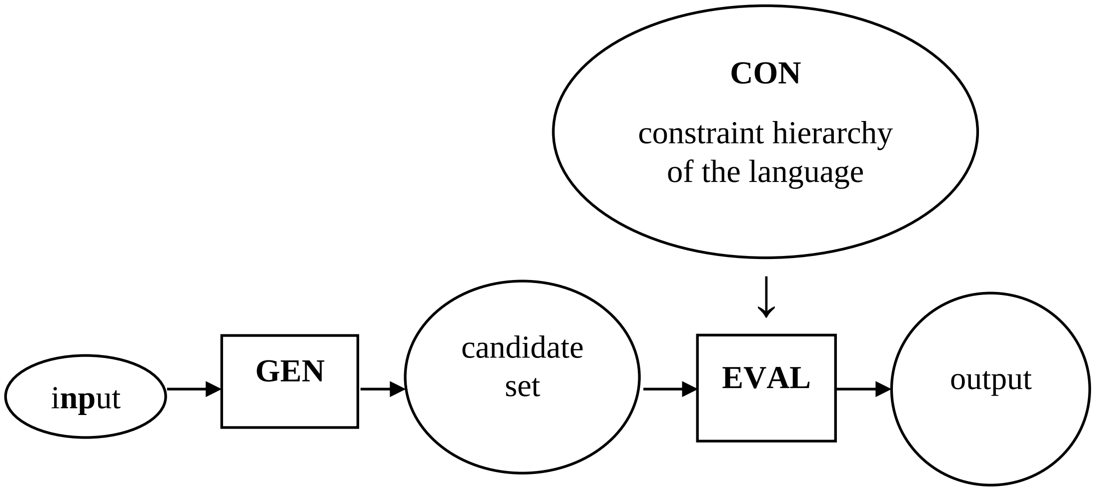

Figure 1: The "architecture" of Optimality Theory from Archangeli (1999).

KEY:

Oval: grammar of language (LG).

Box: Universal Grammar.

Circle: derived by interaction of UG and LG.

GEN

The function GEN, is a clipped form of "generator" (Prince & Smolensky, 2004, p. 5) which generates a candidate that is the same as the actual output form in addition to several candidates that differ from the actual output in some ways. The differences may be in "the features of the corresponding elements, … by the order of the corresponding elements; … and by a mismatch in the number of elements..." (Archangeli, 1999, p. 538). GEN may equally generate candidates that do not in any way correspond to the input. GEN, according to McCarthy (2007) is universal and as such it "anticipates" the various ways by which an input could be transformed in a language to ensure that all the choices are present in the candidate sets that it generates. The candidates are then submitted to EVAL.

EVAL

This function evaluates the candidates generated and submitted to it by GEN. The evaluation follows from a set of ranked constraints by means of which the *most harmonic* or *optimal* candidate is selected as the output for that particular grammar. McCarthy (2007, pp. 4-5) provides the following illustration:

Assume that the hierarchy consists of the constraints C1, C2, and C3, in that order, and that the candidate set is {*cand1*, *cand2*, *cand*3}. If *cand2* violates top-ranked C1 less than both *cand1* and *cand3* violate it, then *cand2* is optimal. If, on the other hand, cand1 and *cand2* both violate C1 equally, and if they violate C1 less than *cand3* does, then *cand3* is out of the running and the choice between *cand1* and *cand2* goes to C2, so on from there.

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In addition, according to him, the constraints in the above example are ranked "[C1 >> C2 >> C3][1]" such that constraint C1 dominates C2 which in turn dominates C3. The implication of such ranking is that "satisfaction of C1 is categorically more important than satisfaction of C2, and satisfaction of C2 is categorically more important than satisfaction of C3". However, where the candidates being evaluated are equal on C1 for example, C2 may become the most important constraint to select the winner. "In other words, OT constraints are arranged in strict-domination hierarchies, in which superior performance on lower-ranking constraints can never overcome inferior performance on higher-ranking constraints."

In the grammar, the only language-specific component is constraint ranking; GEN, EVAL as well as the constraints (which are contained in the set CON) are said to be universal. EVAL is responsible for the selection of the winning candidate if a constraint that favours the winning candidate dominates any or all the constraints that would prefer the non-optimal candidate.

Fatal violation of high-ranking constraints occurs when all higher-ranked constraints tie in violation or satisfaction – a situation known as *the emergence of the unmarked* – TETU (McCarthy & Prince, 1994). The candidate without a fatal violation is selected as the optimal candidate. The winner is indicated by a forward pointing hand (☞). On the other hand, if a wrong candidate is selected based on the constraints and their ranking, such a false winner is indicated by a backward pointing hand (☜) in which case, another constraint or a re-ranking of existing constraints may be required so that the attested output can emerge as the winner. A dominant constraint will usually compel a violation of violable constraints because "[T]he means that a grammar used to resolve conflicts is to rank constraints in a *strict dominance hierarchy*. Each constraint has absolute priority over all the constraints lower in the hierarchy" (Prince & Smolensky, 1993, p.2, emphasis in original).

CON

CON is the "universal constraint component" which encompasses all the constraints that are present in the grammars of all languages. The constraints, as noted above, are universal and only their ranking is language-specific. CON, according to McCarthy (2007), comprises two constraint types: *markedness* constraints and *faithfulness* constraints (both explained below).

Markedness constraints

The constraints are described by Kager (2004, p.9) as the constraints that "require that output forms meet some criterion of structural well-formedness". These may be in the form of banning the occurrence of "marked phonological structures" which may include types of sounds, "prosodic structures" or sequences of sound types in given contexts. These constraints are said to be sensitive only to output forms and because they show a preference for some configurations over others, McCarthy (2007) points out that they are always in conflict with structure-preserving *faithfulness* constraints. A conciliatory effect to the requirements of *markedness* constraints is provided by the violability of constraints. Some examples of *markedness* constraints are given in (1).

(1) Examples of *Markedness* constraints (from Kager, 2004, p.9).

[1] >> indicates "dominates".

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a. Vowels must not be nasal.

b. Syllables must not have codas.

c. Obstruents must not be voiced in coda position.

d. Sonorants must be voiced.

e. Syllables must have onsets.

f. Obstruents must be voiced after nasals.

***Faithfulness* constraints**

Kager (2004, p.10) explains that these constraints "require that outputs preserve the properties of their basic (lexical) forms, requiring some kind of similarity between the output and its input". McCarthy (2007) describes *faithfulness* constraints as "inherently conservative" because they insist on a one-to-one correspondence between the output of the grammar and its input. Therefore, they are always in conflict with *markedness* constraints. He points out that "ranking" resolves this conflict. Examples of *faithfulness* constraints are provided in (2).

(2) Examples of faithfulness constraints (from Kager, 2004, p.10).

a. The output must preserve all segments present in the input.

b. The output must preserve the linear order of segments in the input.

c. Output segments must have counterparts in the input.

d. Output segments and input segments must share values for [voice].

According to Archangeli (1999), *faithfulness* constraints require that input and output correspond. These constraints are embodied in the general theory of correspondence as postulated by McCarthy & Prince (1995, p.262), reproduced in (3) emphasis in original.

(3) Correspondence

Given two strings S1 and S2, **correspondence** is a relation $\Re$ from the elements of S1 to those of S2. Elements $\alpha \in S1$ and $\beta \in S2$ are referred to as **correspondents** of one another when $\alpha \Re \beta$.

In addition to the above constraints, Sokoto Fulfulde syllables are overwhelmingly syllable contact-compliant. Syllable Contact (Vennemann, 1988), as discussed below, is critical in the description of the Sokoto Fulfulde data.

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Syllable Contact

Syllable Contact plays a pivotal role in Sokoto Fulfulde syllabification. The co-occurrence relationship evident among adjacent segments in the lexical items of the dialect provides a motivation for a Syllable Contact constraint in line with the Syllable Contact Law (Vennemann 1988, p.40). The constraint is stated in (4).

(4) *Syllable Contact Law*

A syllable contact A$B is the more preferred, the less the consonantal strength of

the offset A and the greater the consonantal strength of the onset B.

This paper however, follows the version of the Law as rearticulated by Davis (1998, p.182) because "the concept of sonority and consonantal strength are not the same" as reproduced in (5).

(5) *Syllable Contact Law* (sonority version).

A syllable contact A$B is the more preferred, the greater the sonority of the offset

A and the less the sonority of the onset B.

A more explicit interpretation of the law is found in Bat-El (1996) who argues for a syllable contact family of constraints in Optimality Theory, noting in her analysis of Hebrew blends, that such constraints are crucial in the explanation of the contact correspondences. In (6), her paraphrase of the Syllable Contact Law is given.

(6) σCONT (Bat-El, 1996:304)

The onset of a syllable must not be of greater sonority than the last segment in

the immediately preceding syllable.

It is argued that the constraint in (6) can be motivated based on the data available with respect to the Sokoto dialect of Fulfulde. This is because, among the seven remedies for "bad syllable contact" identified by Vennemann (1988, p.50-51), at least two are evident in this dialect. These are exemplified in (7).

(7) Syllable contact-induced changes in Sokoto Fulfulde:

a. Coda weakening: /hof-ru/ → [how-ɾʊ] 'knee'

/woɓ-ru/ → [wow-ɾʊ] 'mortar'

/doomb-ru/ → [do:w-ɾʊ] 'mouse'

b. Contact anaptyxis: /wud-re/ → [wʊd-e-ɾe] 'cloth for women'

/hit-re/ → [hɪt-e-ɾe] 'eye'

/yok-re/ → [jok-e-ɾe] 'genitals' (vulg.).

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Although it may be argued that the cases of coda weakening follow from the universal constraints on ideal coda and onset types (Davis, 1998), the manifestation of contact anaptyxis is without any phonological motivation – the examples in (7b) are licit clusters. In addition to the above, there is a process of "n-lateralization" as shown in (8), a similar occurrence of which is reported among others, in Korean (Davis, 1998, p.209); a language in which "SyllCon is never violated":

(8) "n-lateralization" in Sokoto Fula:

/con-li/ → [ʧol-lɪ] 'birds'

/ɓun-li/ → [ɓʊl-lɪ] 'wells'

/ɓan-li/ → [ɓɑl-lɪ] 'bodies'

To recapitulate, Sokoto Fulfulde syllables, from the data for this research, are Syllable Contact-compliant, although there are a few cases that the constraint has not helped to address. One of these is [hem-ɾe] 'hundred', with rising sonority over the syllable boundary. It is the only token in the entire data with an m-r combination[2] which would have been explained away as an exception but for the occurrence of other Syllable Contact-violating sequences. The difficulty encountered here is twofold: if the Syllable Contact constraint is not violable, offending outputs like *hem.re* 'hundred', *wol.wi* 'spoke', *wur.wi* 'stirred (soup)' will be unattested in the dialect. If on the other hand, the constraint is violable, faced with candidates like *wow-ru* 'mortar' and **woɓ-ru*, it will be hard to eliminate the latter in favour of the former. A promising alternative will be to take recourse to the *Syllable Contact Slope* (Bat-El, 1996, p.305) stated in (9).

(9) σCONTSLOPE

The greater the slope in sonority between the onset and the last segment in the immediately preceding syllables, the better.

With the constraint in (9) and the syllable contact constraint stated in (5), the singular noun *wow-ru* [wow-ɾʊ] 'mortar' (pl. *boɓ-i* [boɓ-ɪ]) is evaluated alongside two sub-optimal candidates in the tableau in (12). In addition to the two constraints above, since the input is /boɓ-/ and the attested output is [wow-ɾʊ], there is a violation of a featural identity constraint by the actual output candidate. This calls for a constraint penalising such a violation. Such a constraint is of the IDENT family as reproduced in (10) from McCarthy & Prince (1995, p.370).

(10) IDENT (F).

Correspondent segments have identical values for the feature F.

If x$\Re$y and x is [γF], then y is [γF].

[2] These are frequently occurring combinations in some Fula dialects such as Gombe (Arnott, 1970) in words like *shom-ri* 'tiredness' (p.84), *doom-ru* 'rat' (p.114), etc.

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The constraint is *relativized* to the [manner] feature in (11).

(11) IDENT-MANNER

Correspondent input and output segments share identical [manner] features.

(12) Tableau for [wow-ɾʊ] 'mortar (sg.)'.

	/boɓ- + ɾʊ [+CONT]/	σCONT	σCONTSLOPE	IDENT-MANNER
☞	a. [wow-ɾʊ]			*
	b. [woɓ-ɾʊ]	*!		
	c. [woɾ-ɾʊ]		*!	

In (12), the constraint in (9) effectively produces the desired result. The most faithful candidate (b) is thrown out by σCONT and candidate (c) which has segments of equal sonority, even though satisfying syllable contact, is eliminated by σCONTSLOPE which requires a slope in sonority, selecting the attested candidate (a) as optimal. There is nevertheless a problem with this approach because σCONTSLOPE will rule out all geminate clusters because they involve flat sonority – no slope. It will equally obviate the need for its introduction in the first place because cases of rising sonority onsets like *hem-re* 'hundred', *wol.wi* 'spoke', and *wur.wi* 'stirred (soup)' mentioned above will equally be ruled out. This dilemma leads to the adaptation of the *The Inverse Place Condition* (Cser, 2012, p.52) repeated in (13) below, to partly explain the cases of rising sonority onsets.

(13) *The Inverse Place Condition*

Heterosyllabic clusters consisting of non-nasal sonorants are well-formed irrespective of sonority relations if C1 is coronal and C2 is non-coronal (i.e. [lw rw jw] are well-formed). If C2 is coronal, only sonority relations are decisive (i.e. [wr wl jr jl] are well-formed, *[rl lr lj rj wj] are not).

The condition in (13) partly provides an escape route for explaining the combinations that violate both Syllable Contact and Syllable Contact Slope. The question of *hem-re* 'hundred' remains unanswered however. The relevance of these critical constraints alongside other not so critical ones to the syllabification of segments in Sokoto Fulfulde will be seen in due course.

Syllabification

This section presents a description of syllabification in the Sokoto dialect of Fulfulde under Optimality Theory (Prince & Smolensky, 1993; McCarthy & Prince, 1993; Prince & Smolensky, 2004). Like other phonological aspects of the language, syllable structure has been

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studied by many researchers including Arnott (1970), Paradis (1992) and Breedveld (1995); hence, those interested in Fulfulde are familiar with this. What makes the Sokoto dialect syllabification different is its conformity with the *Syllable Contact Law* (Vennemann, 1988) which produces stem-final alterations, some of which are not found in other Fulfulde dialects.

General Properties of Sokoto Fula Syllables

This section describes the components of the syllable in the Sokoto dialect of Fulfulde.

Nucleus

Syllable nuclei are obligatory in many languages; the Sokoto dialect of Fulfulde is no exception as all its syllables have them. Additional observations about the nucleus in Sokoto Fulfulde is that only vowels – short or long – are nuclear; syllabic consonants are not attested as in English.

a. The nucleus is obligatory.

b. Only vowels are nuclear; syllabic consonants are not allowed.

c. The nucleus may be a short or a long vowel.

d. The rhyme is minimally composed of a single segment, i.e. a short vowel.

e. The rhyme is maximally composed of four segments, i.e. VVCC (a long vowel) plus a maximum of two coda consonants. The caveat however, is that a VV sequence can only be one set of features, not two.

Onset

Fulfulde language has a preference for syllables with onsets; vowel initial words are realised with the insertion of a glottal stop as many studies have shown. This reveals that a minimum syllable in Sokoto Fulfulde is CV. This leads to the following generalisations about the Onset:

a. Onset is obligatory.

b. Onset is simple; either a single consonant, e.g. *der* [deɾ] ‘inside’ or a glottal stop, e.g. an [ʔɑn] ‘you (2SG)’ constitute the Onset.

c. Complex Onsets are not allowed.

Coda

Both syllables with codas and those without them occur in all dialects of Fulfulde. Both types occur with nearly equal frequency. This leads to the following generalisation about codas in the Sokoto dialect of Fulfulde.

a. The coda is optional.

b. The coda minimally comprises a single consonant, e.g. *ɗe**n**-gol* [ɗeŋ.gol] ‘sleep’.

c. Complex codas are allowed but maximally comprise two consonants, e.g. *to**rn**.de* [toɾn.de] ‘begging’.

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d. Complex codas are restricted to word-medial position, e.g. *uurn.gol* [uːɾŋ.gol] 'nice/pleasant smell'; word-final complex codas are not allowed.

The occurrence of complex codas provides anecdotal evidence that the maximum syllable type in the Sokoto dialect is CVVCC. The distribution of coda consonants in Sokoto dialect is generally restricted. Except in geminates, which always occur in intervocalic and hetero-syllabic positions, simple word-medial codas are limited to the glides [w, j], the liquids [ɾ, l] and the nasals [m, n, ŋ]. These attested coda consonants (excluding half of geminates) form a natural class – they are all sonorants. The following statements are therefore pertinent:

a. The first segment is always one of the glides /w/ and /j/ or one of the liquids /r/ or /l/.

b. The second segment is always a nasal which must be homorganic with the following stop.

In what follows, an analysis of syllabification in the Sokoto dialect of Fulfulde is undertaken, taking into consideration initially, the *markedness* constraints outlined in (15) while other constraints will be introduced as they become relevant.

15. *Markedness* constraints governing syllable structure (Archangeli 1999; Peng, 2003; Prince & Smolensky 2004).

a. ONSET: *[σ V (Syllables must have Onsets or must not begin with a vowel).

b. NO-CODA: *C] σ (Syllables are open or must not end with a consonant).

c. *COMPLEX$^{ONSET:}$ *[σ CC (Onsets are simple and must not include more than one consonant).

d. *COMPLEX$^{CODA:}$ CC] σ (Codas are simple and must not include more than one consonant).

e. NUC: Syllables must have a nucleus.

Syllabification of Consonant-initial Words in Sokoto Fula

The analysis of syllabification in terms of Optimality Theory begins with a CVCC.CVC noun, *durngol* [dʊɾŋgol] 'herding' using the constraints identified above by means of a pairwise comparison. The first noun evaluated is bi-syllabic and parsed as [dʊɾŋ.gol]. Since this is the optimal form, many sub-optimal candidates will be generated along the line to show why the attested output is the optimal form. First, a sub-optimal candidate [dʊ.ɾŋgol] is generated and compared with the attested one in order to establish the constraints that differentiate them in the tableau in (16). For reasons of space, the constraints *COMPLEX^{ONSET} and *COMPLEX^{CODA} are represented in the tableaux as *CX^{O} and *CX^{C} respectively. As no ranking has been established yet, dashed lines are used to show the absence of a critical ranking between the constraints.

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16. Tableau for [dʊrŋ.gol] 'herding'.

	/dʊrŋgol/	ONSET	NO-CODA	*CXO	*CXC	NUC
	a. [dʊrŋ. gol]		**		*	
	b. [dʊ.rŋ gol]		*	*		

The tableau in (16) indicates that both candidates differ from each other with respect to NO-CODA, *COMPLEX^{ONSET}; and *COMPLEX^{CODA}. No other constraint is significant in distinguishing them. The attested candidate has two violations of NO-CODA and one violation of *COMPLEX^{CODA} whereas the sub-optimal candidate has one violation of NO-CODA. The sub-optimal candidate in addition, has a violation of *COMPLEX^{ONSET}. The ranking of these three constraints as done in (17), is therefore crucial in the determination of which candidate is optimal.

17. Tableau for [dʊrŋ.gol] 'herding'.

	/dʊrŋgol/	*CXO	NO-CODA	*CXC
☞	a. [dʊrŋ. gol]		**	*
	b. [dʊ.rŋ gol]	*!	*	

The ranking, as established in (17) above – indicated by solid lines – correctly selects the attested [dʊrŋ.gol] as the optimal candidate because even though it has two violations of the lower ranked NO-CODA and one violation of *COMPLEX^{CODA} relative to a single violation of NO-CODA and no violation of *COMPLEX^{CODA} by the sub-optimal candidate, it is still better. By incurring a fatal violation of the dominant constraint, the performance of candidate (b) on the next constraint is inconsequential. This is so because of the *Principle of Strict Domination* (McCarthy, 2007, p.5) which states that violation of a higher ranked constraint cannot be mitigated by the satisfaction of a lower ranked one. Candidate (a) wins by circumventing a violation of the higher ranked *COMPLEX^{ONSET}. The sub-optimal candidate violates this constraint – a violation that is fatal in view of the ranking. The tableau indicates that *COMPLEX^{ONSET} dominates both NO-CODA and *COMPLEX^{CODA} which are unranked with respect to each other. This is because if either is made dominant, it will select the sub-optimal candidate. The appropriate (interim) ranking of the two constraints in this Fula dialect is therefore as given in (18).

18. *COMPLEX^{ONSET} >> NO-CODA, *COMPLEX^{CODA}

Turning to the requirement that all syllables must have a vocalic element, the attested [dʊrŋ.gol] is compared with the sub-optimal candidate [dʊr.ŋ.go.l] in (19).

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19. Tableau for [dʊrŋ.gol] 'herding'.

	/dʊrŋgol/	NUC	NO-CODA
☞	a. [dʊrŋ.gol]		**
	b. [dʊ.r.ŋ.go.l]	*!**	

The constraints in (19) select the attested candidate (a) as the optimal candidate. The losing candidate (b) incurs a fatal violation of NUC as it has syllables without nuclei. Recall from earlier discussion that syllabic consonants cannot be nuclear in Fulfulde. The undominated constraint NUC is therefore ranked alongside *COMPLEX^{ONSET} in a revised ranking from (18) above.

20. *COMPLEX^{ONSET}, NUC >> NO-CODA, *COMPLEX^{CODA}

So far, four of the five *markedness* constraints governing syllabification have been evaluated in relation to the Sokoto dialect of Fulfulde. Two of these – *COMPLEX^{ONSET} and NUC are high-ranking as shown in (20) while two – NO-CODA and *COMPLEX^{CODA} are violable and hence, low-ranked.

What is not clear yet is the ranking of ONSET. To determine this, a further comparison is made between the attested [dʊrŋ.gol] and another sub-optimal candidate [dʊrŋg.ol] in which each has syllables with codas but the sub-optimal candidate has a syllable without an onset. The constraints ONSET and NO-CODA are used in evaluating them in the tableau in (21).

21. Tableau for [dʊrŋ.gol] 'herding'.

	/dʊrŋgol/	ONSET	NO-CODA
☞	a. [dʊrŋ.gol]		**
	b. [dʊrŋg.ol]	*!	*

The tableau in (21) shows that the attested [dʊrŋ.gol] satisfies ONSET but incurs two violations of NO-CODA whereas the sub-optimal [dʊrŋg.ol] violates ONSET but suffers only one violation of NO-CODA.

However, a candidate like [dʊrŋ.gol] which has both coda [rŋ] and [l] unsyllabified will always erroneously emerge as the winner irrespective of how ONSET and NO-CODA are ranked with respect to each other as shown in (22).

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22. Tableau for [dʊɾŋ.gol] ‘herding’.

	/dʊɾŋgol/	ONSET	NO-CODA
	a. [dʊɾŋ.gol]		*!*
☜	b. [dʊɾ̱ŋ̱.goḻ]		

To get the attested [dʊɾŋ.gol] selected over the sub-optimal [dʊɾ̱ŋ̱.goḻ], another constraint must be introduced – a *faithfulness* constraint, stated in (23), from Kager (2004, p.100).

23. PARSE

‘underlying segments must be parsed into syllable structure’

With the constraint in (23), the candidates in (22) are re-evaluated in (24).

24. Tableau for [dʊɾŋ.gol] ‘herding’.

	/dʊɾŋgol/	PARSE	NO-CODA
☞	a. [dʊɾŋ.gol]		**
	b. [dʊɾ̱ŋ̱.goḻ]	*!*	

In (24), the attested candidate (a) is selected as the optimal candidate even though it has two violations of NO-CODA. The losing candidate (b) circumvents a violation of this constraint by leaving its coda consonants unparsed. It however, fatally violates the dominant PARSE and is thus eliminated. The ranking is crucial as shown by the solid lines in the tableau.

With the established ranking in which PARSE outranks NO-CODA, all the five *markedness* constraints that govern syllable structure have been evaluated as they relate to the Sokoto dialect. It is however, necessary that these *markedness* constraints interact with *faithfulness* constraints, to handle the syllabification of segments. A ranking schema for these constraints is given in (25).

25. *COMPLEX^{ONSET}, NUC, ONSET, PARSE >> NO-CODA, *COMPLEX^{CODA}

*COMPLEX^{ONSET}, NUC, ONSET and PARSE must be undominated and ranked above NO-CODA and *COMPLEX^{CODA}, both of which are violable and unranked with respect to each other.

Having evaluated a reasonable number of sub-optimal candidates and arrived at identifying six syllable-related constraints and their relative ranking in this dialect of Fulfulde, a tableau for all the candidates so far evaluated is provided in (26) so that at a glance, it is possible to see which constraint each of the candidates violates and why the attested candidate remains optimal.

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26. Tableau for [dʊɾŋ.gol] 'herding'.

	/dʊɾŋgol/	*CX^{ONSET}	NUC	ONSET	PARSE	NO-CODA	*CX^{CODA}
☞	a. [dʊɾŋ.gol]					**	*
	b. [dʊ.ɾŋgol]	*!				*	
	c. [dʊ.ɾ.ŋ.go.l]		*!				
	d. [dʊɾŋg.ol]			*!		**	*
	e. [dʊɾŋ̲.gol̲]				*!		
	f. [dʊɾŋ.g.ol]		*!	*!		**	*
	g. [dʊɾŋ.go.l]		*!			*	*

The picture emerging from the preceding analysis is that syllabification in the Sokoto dialect of Fulfulde may be accounted for by six constraints in two tiers: the five *markedness* constraints and one *faithfulness* constraint: *COMPLEX^{ONSET}, NUC, ONSET and PARSE ranked at the higher level, dominating NO-CODA and *COMPLEX^{CODA}. The constraint hierarchy in (26) is therefore absolute but what is not clear is how these constraints interact with additional *faithfulness* constraints that may be introduced in the course of the discussion. This is examined in the next section.

Syllabification of Glottal Stop-initial Words in the Sokoto Dialect of Fulfulde

In the preceding section, the syllabification of [dʊɾŋ.gol] 'herding', a bi-syllabic noun with two onsets and two codas is considered. In this section, the syllabification of a word – a verbal complex – that is different from [dʊɾŋ.gol] 'herding' is examined. It is a verbal complex, *aɗowallita* 'you (2SG.) do help out'. It has already been mentioned earlier that syllables without onsets are not attested in the Sokoto dialect of Fulfulde. The argument that the glottal stop is not underlying but inserted is supported by the following illustrations.

27. DEP-IO

'Every element of S_2 has a correspondent in S_1'

The constraint in (27) is paired alongside the undominated ONSET in the tableau in (28).

28. Tableau for [ʔɑ.ɗo.wɑl.lɪ.tɑ] 'you (2SG.) do help out'.

	/ɑɗowɑllɪtɑ/	ONSET	DEP-IO
☞	a. [ʔɑ.ɗo.wɑl.lɪ.tɑ]		*
	b. [ɑ.ɗo.wɑl.lɪ.tɑ]	*!	

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In (28), the attested candidate (a) wins against the sub-optimal candidate (b) which incurs a fatal violation of ONSET. The outcome shows the undominated ranking of ONSET because the winning candidate is selected despite a violation of DEP-IO since it satisfies the dominant constraint. With candidate (b) losing, following a violation of ONSET, another candidate that circumvents a similar violation, [ɗo.wal.lɪ.tɑ], is presented. As usual, it is paired against the attested [ʔɑ.ɗo.wɑl.lɪ.tɑ]. The two differ with respect to only one segment – the deleted first syllable that has no onset. This is intended to determine whether the language resorts to deletion to improve the well-formedness of its syllables. As both candidates have no ONSET violation and have equal violation marks on NO-CODA, the only constraint that can decide between them is a *faithfulness* constraint, MAX-IO, stated in (29). This constraint requires that segments in the input must have correspondents in the output; allowing no deletion. Its effect is demonstrated in (30). Recall that since the attested candidate has an inserted segment and the sub-optimal candidate has a deleted one, the conflict is between *faithfulness* constraints; *markedness* constraints are not relevant.

29. MAX-IO

‘Every element of S1 has a correspondent in S2’

30. Tableau for [ʔɑ.ɗo.wɑl.lɪ.tɑ] ‘you (2SG.) do help out’.

	/ɑɗowɑllɪtɑ/	MAX-IO	DEP-IO
	a. [ʔɑ.ɗo.wɑl.lɪ.tɑ]		*
	b. [ɗo.wɑl.lɪ.tɑ]	*	

In (30), the constraints are not ranked with respect to each other. If MAX is ranked over DEP, the attested candidate (a) will be selected because the sub-optimal candidate (b) has a deletion of an input segment. A reversal of the ranking will change the outcome because the actual output candidate (a) will be eliminated by DEP for having an inserted segment. This will lead to the selection of the sub-optimal candidate (b) as the winner. The ranking in which MAX dominates DEP is therefore the crucial one.

In a revised schema in (31), MAX is ranked between the undominated constraints and the dominated ones until evidence for a review of such ranking becomes manifest.

31. *COMPLEX^{ONSET}, NUC, ONSET, PARSE >> MAX-IO >> DEP-IO, NO-CODA, *COMPLEX^{CODA}

With the ranking in (31), a final tableau for [ʔɑ.ɗo.wɑl.lɪ.tɑ] ‘you (2SG.) do help out’ is given in (32). The *COMPLEX constraints are abbreviated for reasons of space.

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32. Tableau for [ʔɑ.ɗo.wɑl.lɪ.tɑ] 'you (2SG.) do help out'.

	/ʔɑɗowɑllɪtɑ/	*CX^{O}	NUC	ONSET	PARSE	MAX	DEP	NO-CODA	*CX^{C}
☞	a. [ʔɑ.ɗo.wɑl.lɪ.tɑ]						*	*	
	b. [ʔɑ.ɗo.wɑ.llɪ.tɑ]	*!					*		
	c. [ʔɑ.ɗ.wɑl.lɪ.tɑ]		*!				*	*	
	d. [ɑ.ɗo.wɑl.lɪ.tɑ]			*!				*	
	e. [ʔɑ.ɗo.wɑl̲.lɪ.tɑ]				*!				
	f. [ɗo.wɑl.lɪ.tɑ]					*!		*	

The discussion leading to the construction of the preceding tableaux shows the relevance of both *markedness* and *faithfulness* constraints to syllabification in Sokoto Fulfulde. What has yet to be demonstrated is how these constraints handle the puzzling rhyme-internal alterations found in the language which lead researchers to describe the language as "very complex" (Paradis 1992, p.7).

Following the acknowledged occurrence of geminate structures in Fulfulde literature, coupled with stem-final consonants that are significantly homorganic with the following stop particularly in syllables with complex codas suggest at first sight, that such alterations are cases for a constraint like Coda Condition (Itô, 1989 in Kager, 2004, p.131; Itô and Mester, 1994), stated in (33), to handle.

33. CODA-COND

*C] σ

|

Place

Codas have no independent place of articulation.

The above constraint requires coda consonants occurring in intervocalic clusters to be either "the first half of a geminate or a nasal preceding a homorganic stop". However, much as some Sokoto Fulfulde syllables conform to this requirement, the majority are in violation.

Syllable Contact

In Fulfulde, noun stems in classes 9, 10 and 11 occur with either -rV or -dV suffixes for different reasons. Some of these reasons are explained in this section. Syllable contact-compliant sequences occur with the -rV variants of the suffixes. Examples are provided in (34).

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34. Examples of stems and suffixes obeying syllable contact in Sokoto Fula.

	Singular		Plural		Gloss
a.	*few.re*	[few.ɾe]	pe.we	[pe.we]	a lie
b.	*joow.re*	[ʤo:w.ɾe]	joo.we	[ʤo:.we]	heep
c.	*gaw.ri*	[gɑw.ɾɪ]	ga.wee.je	[gɑ.wee.ʤe]	grain
d.	*saw.ru*	[sɑw.ɾʊ]	cab.bi	[ʧɑb.bɪ]	stick
e.	*lew.ru*	[lew.ɾʊ]	leb.bi	[leb.bɪ]	month

In the examples in (34), there is no violation of syllable contact in the singulars, because the coda consonants are more sonorous than the following onsets. In the plurals, the codas are syllabified as onsets of the following syllables in (34a, b. and c.). In (34d and e) there is stem alternation involving singletons and geminates. In situations where sequences of segments in contact violate Syllable Contact, they are repaired through coda-weakening to ensure compliance as shown in (35).

Coda weakening

As mentioned above, syllables in the Sokoto dialect of Fulfulde conform to the *Syllable Contact Law* (Vennemann, 1988). As a result, segment sequences that violate the Law are repaired through different strategies. One of these is coda weakening as exemplified in (35).

35. Examples of syllable contact-induced coda-weakening[3].

a.	*haw.re*	[hɑw.ɾe]	*ka.ɓe*	[kɑ.ɓe]	'fight' from *haɓ-* *haɓ.re
b.	*tay.re*	[tɑj.ɾe]	*ta.ƴe*	[tɑ.ʧ'e]	'piece of meat' from *taƴ-* *taƴ.re
c.	*boy.ri*	[boj.ɾɪ]	*bo.see.je*	[bo.se:.ʤe]	'porridge' from *wos-* *bos.ri
d.	*faaw.ru*	[fɑ:w.ɾʊ]	*paa.ɓi*	[pɑ:.ɓɪ]	'frog' from *faaɓ-* *faaɓ.ru
e.	*wow.ru*	[wow.ɾʊ]	*bo.ɓi*	[bo.ɓɪ]	'pounding mortar' *woɓ.ru
f.	*doow.ru*	[do:w.ɾʊ]	*doom.bi*	[do:m.bɪ]	'rat' *doomb.ru
g.	*how.ru*	[how.ɾʊ]	*kop.pi*	[kop.pɪ]	'knee' from *hof-* *hof.ru

In the examples in (35) are instances of rising sonority onsets which violate syllable contact. From (35a-e) are cases in which the offending segments are "weakened" in the singulars to conform to the requirements of Syllable Contact, but the same segments surface in the plurals, syllabified as onsets of the following syllables. The representative tableau in (37) for *haw-re* [hɑw.ɾe] 'fight' shows the effect of the syllable contact constraint. Taking the noun pair *haw-re/kaɓ-e* [hɑw-ɹe/kɑɓ-e] 'fight(s)' shows that the forced coda-weakening results in a violation of [manner] feature faithfulness by the attested candidate. The constraint militating against the violation of manner features, is stated in (36) and is low-ranking. From this section onwards, the five *markedness* constraints that govern syllable structure are not included in the tableaux. It is assumed that any attested candidate must have an Onset, a Nucleus and must not have a complex Onset. Attested candidates may however have codas and complex codas.

[3] Examples of "coda weakening" are reported in Hausa (Klingenheben, 1928 in Vennemann, 1988:26) as shown in these examples .
ma.kaf.ni.ya > *ma.kaw.ni.ya* 'a blind one (fem.)'.
ta.lak.či > *ta.law.či* 'poverty'
hag.ni > *haw.ni* 'left side'
fat.ke > *far.ke* 'merchant'

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36. IDENT-MANNER (Davis, 1998).

Correspondent input and output segments share identical [manner] features.

37. Tableau for [hɑw.ɾe] 'fight'

	/kaɓ- + ɾe [+CONT]/	σ-CONT	IDENT [MANNER]
	a. [hɑɓ.ɾe]	*!	
☞	b. [hɑw.ɾe]		*

In (37), the overriding constraint is fatally violated by candidate (a), thus paving the way for the emergence of the actual output candidate (b) as the winner with a non-fatal MANNER violation. The plural correspondent, *kaɓ-e*, syllabified as [kɑ.ɓe], surfaces with the underlying labial implosive because it syllabifies it as an onset of the following syllable; thus, avoiding a violation of syllable contact.

Going back to the data in (35), the example in (35f) shows not only coda weakening but in addition, a deleted segment. Since the output with the deleted segment in the singular is the attested form, the anti-deletion constraint, stated above and ranked as undominated, is violable after all. Thus, the ranking in (31) is revised in (38), placing MAX alongside other violable constraints.

38. *COMPLEX^{ONSET}, NUC, ONSET, PARSE >> MAX-IO, DEP-IO, NO-CODA, *COMPLEX^{CODA}

In (39), it is shown why *doow-ru* [do:w.ɾʊ] 'rat' with a deleted input segment is better than **doomb.ru* which has no deletion since this Fulfulde dialect allows complex codas.

39. Tableau for [do:w.ɾʊ] 'rat'.

	/do:mb- + ɾʊ/	σ-CONT	MAX-IO	IDENT [MANNER]
	a. [do:mb.ɾʊ]	*!		
☞	b. [do:w.ɾʊ]		*	*
	c. [do:m.ɾʊ]	*!		
	d. [do:b.ɾʊ]	*!		
	e. [do:.ɾʊ]		**!	

In (39), the attested output [do:w.ɾʊ] is selected by the highest-ranking constraint even though it violates the two lower-ranked constraints with a deleted segment in violation of MAX and a weakened coda in violation of MANNER. The losing candidates are removed for violating different constraints: [do:mb.ɾʊ], [do:m.ɾʊ] and [do:b.ɾʊ] violate syllable contact as they have rising sonority in the onsets of the following syllables. [do:.ɾʊ] is eliminated for incurring two violations of MAX. In the plural [do:m.bɪ], the weakened nasal survives because as a coda

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consonant, it is more sonorous than the deleted labial stop in the singular which is syllabified as an onset of the following syllable in the plural. Another syllable-contact related repair strategy is anaptyxis.

Contact anaptyxis

As the examples in (40) show, anaptytic vowels are inserted to syllabify stem-final syllable contact-violating consonants preceding -rV suffixes.

40. Examples of contact anaptyxis

UR		SR				
		Singular		**Plural**		**Gloss**
a.	/kols-re/	*hol.se.re*	[hol.se.ɾe]	*kol.ce*	[kol.ʧe]	'hoof'
b.	/gud-re/	*wu.de.re*	[wʊ.de.ɾe]	*gu.de*	[gʊ.de]	'woman's cloth'
c.	/lins-re/	*lin.se.re*	[lɪn.se.ɾe]	*lin.ce*	[lɪn.ʧe]	'rag'
d.	/kin-re/	*hi.ne.re*	[hɪ.ne.ɾe]	*ki.ne*	[kɪ.ne]	'nose'
e.	/ʤɑwd-ri/	*jaw.di.ri*	[ʤɑw.dɪ.ɾɪ]	*jaw.dî*	[ʤɑw.dî]	'ram'
f.	/bʊkk-rʊ/	*wuk.ku.ru*	[wʊk.kʊ.ɾʊ]	*buk.ki*	[bʊk.kɪ]	'bunch'
g.	/gʊtt-rʊ/	*wut.tu.ru*	[wʊt.tʊ.ɾʊ]	*gut.ti*	[gʊt.tɪ]	'stomach (pej.)'

An examination of the data in (40) reveals that the nouns in their underlying forms cannot be syllabified following the high-ranking nature of the syllable contact constraint. They contain consonant sequences that involve rising sonority onsets and this explains the occurrence of the "anaptytic vowel". The anaptyxis is meant to break up such syllable contact-violating sequences[4].

Compensatory lengthening

The noun pair *ɓoy.re/ɓo.he* [ɓoj.ɾe/ɓo.he] 'baobab fruit(s)' *ɓoh.re, shows a stem-final alteration in which the coda /h/ is weakened in the singular, resulting from the prohibition of /h/ as a coda consonant in Fulfulde as widely reported in the literature (e.g. Arnott, !970, p.117; Paradis, 1992, p.148). This explains why in the singular, the semi-vowel /j/ replaces it to conform to the requirements of syllable contact while it remains in the plural as a syllable onset[5]. The tableau in (42) shows the derivation of [ɓoj.ɾe] which has a violation of place, the constraint against which is stated in (41).

[4] Arnott (1970:110-111) explains that in Gombe Fula, "[t]he anaptytic vowel occurs in any CVCC-stem (ending in a consonant cluster, whether geminate or not) and some CVC- and CVCC-stems where the stem-final consonant is in the range **sh, k, t, d, j, g, nd**" (emphasis in original). This observation holds for Sokoto Fula as well, except that [ʃ] does not occur in the dialect; [s] and [ʧ] are found instead. Similarly, [n] is found among such stem-final consonants in Sokoto Fula but following the non-occurrence of pre-nasalised stops, **nd** is not.

[5] In Pulaar, [h] is only deleted when followed by another consonant; it survives as a word-final consonant as Paradis (1992:150) explains, citing the examples *ma mi mah* 'I will build' and *ma mi yah* 'I will go'. Data for this research however suggest that in Sokoto Fula, coda [h] is not allowed in any position. Arnott (1970:193) equally in a footnote, notes the non-occurrence of final [h] in Gombe Fula.

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41. IDENT-IO [PLACE]

Correspondent input and output segments share identical [place] features.

42. Tableau for [ɓoj-ɾe] 'baobab fruit' (SG.).

	/ɓoh- + ɾe	σ-CONT	IDENT-IO [PL.]
	a. [ɓoh.ɾe]	*!	
☞	b. [ɓoj.ɾe]		*

In (42), the losing candidate violates the undominated σ-CONT. Candidate (b), which is the attested candidate wins with a non-fatal violation of PLACE. There are nevertheless, contexts in which the coda /h/ is not replaced by a more sonorous segment but deleted, resulting in compensatory lengthening of the preceding vowel[6]. Examples are found in the words for building: *mah*– 'to build' but [mɑ:-dɪ] 'building' and *yah*– 'to go' but [jɑ:-dʊ] 'way of walking/journey'. The tableau in (43) shows the derivation of [mɑ:.dɪ] 'building'. Since the attested output is the one with a deleted coda, σ-CONT and MAX are used in the evaluation.

43. Tableau for [mɑ:.dɪ] 'building'.

	/mɑh- + dɪ	σ-CONT	MAX-IO
☜	a. [mɑh.dɪ]		
	b. [mɑ:.dɪ]		*!

In (43), the constraints select the fully faithful sub-optimal candidate (a) as the false winner. This is because the dominant σ-CONT cannot eliminate it as its coda [h], is more sonorous than the following onset; thus, obeying syllable contact. The attested candidate (a) is ruled out by MAX. This shows that the case of coda /h/ is not that of syllable contact alone. It equally points to the need for a specific constraint that can remove candidate (a). The constraint is stated in (44).

[6] A similar occurrence is reported in Oromo (Lloret, 1991) in which the deletion of coda [ɗ] results in compensatory lengthening. In (a. i) and (a. ii), [ɗ] deletes as a coda consonant, but in (b. i) and (b. ii), it remains because it is followed by a vowel, which makes it an onset of the following syllable.

a. i. /feɗ-na/ feena 'we wish'
ii. /feɗ-sisa/ feesisa 'I make wish'

b. i. /feɗ-a/ feɗa 'I wish'
ii. /feɗ-aɗɗa/ feɗaɗɗa 'wish for self'

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44. *h] σ

/h/ is not allowed in the coda.

With the additional constraint, the candidates are re-evaluated in the tableau in (46). A third candidate without vowel lengthening must however be added as it will be the most harmonic so that it becomes clear why an output with lengthening is better. It is argued that codas are moraic in the Sokoto dialect of Fulfulde; this is evident from the lengthening of the vowel to compensate for the mora of the deleted coda consonant. A constraint penalising the deletion of a mora is therefore necessary. The constraint is stated in (45).

45. MAX-μ

Input moras have output correspondents.

The constraint is incorporated into the ranking in the tableau in (46).

46. Tableau for [mɑː.dɪ] 'building'.

	/mɑh- + dɪ	σ-CONT	*h] σ	MAX-μ	IDENT-PL.
	a. [mɑh .dɪ]		*!		
☞	b. [mɑː. dɪ]				*
	c. [mɑ. dɪ]			*!	

In (46), the sub-optimal candidate (a) is eliminated for incurring a fatal violation of the constraint militating against /h/ in the coda. The other sub-optimal candidate (c) is also removed because by retaining the underlying short vowel after deleting the coda /h/, it deletes a mora; thus, fatally violating MAX-μ. The attested candidate (b) therefore emerges as optimal since it preserves the mora of /h/ by lengthening the preceding vowel. It however violates [IDENT-place].

Singleton/geminate alternation

Recall from (35) that there is a noun with a stem-final alternation involving a singleton versus geminate consonants. That noun and similar ones are repeated in (47).

47. Singleton noun stems alternating with geminates.

a.	*how-ru*	[how-ɾʊ]	*kopp-i*	[kopp-ɪ]	'knee'
	now-ru	[now-ɾʊ]	*nopp-i*	[nopp-ɪ]	'ear'
b.	*saw-ru*	[sɑw-ɾʊ]	*cabb-i*	[ʧɑbb-ɪ]	'stick'
	lew-ru	[lew-ɾʊ]	*lebb-i*	[lebb-ɪ]	'month'
c.	*waan-de*	[wɑːn-de]	*baal-le*	[bɑːl-le]	'mountain'
	son-du	[son-dʊ]	*col-li*	[ʧol-lɪ]	'bird'
	ɓun-du	[ɓʊn-dʊ]	*ɓul-li*	[ɓʊl-lɪ]	'well'
	ɓan.du	[ɓɑn.dʊ]	*ɓal.li*	[ɓɑl.lɪ]	'body'
d.	*hoon-du*	[hoːn-dʊ]	*koo-li*	[koː-lɪ]	'finger'
	foon-du	[foːn-dʊ]	*poo-li*	[poː-lɪ]	'dove'

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faan-du [fɑːn-dʊ] *paa-li* [pɑː-lɪ] 'gourd'
e. *waan-du* [wɑːn-dʊ] *baa-ɗi* [bɑː-ɗɪ] 'monkey'
rawaan-du [ɾawɑːn-dʊ] *dawaa-ɗi* [dɑwɑː-ɗɪ] 'dog'

The examples in (47a) are cases in which [w] alternates with geminate [p] and in (47b) it alternates with geminate [b]. Recall that the stem-final [w] in the set in (47a) is underlyingly /f/: *how-ru* 'knee' is a deverbal noun from *hof-* 'to kneel' while *now-ru* 'ear' is also *nof-ru* in some Fulfulde dialects (see Arnott, 1970, p.113; Paradis, 1992, p.72; Breedveld, 1995, p.88) but replaced by [w] through coda weakening to conform to syllable contact requirements in the Sokoto dialect. The alternation therefore, is underlyingly f/pp – f/p is an attested alternation pattern in Fulfulde. The alternation in the set in (47b), i.e. w/bb is also licit because w/b alternation is attested in Fulfulde. There is no evidence that the [w] is underlyingly a different sound in (47b). What is in contention is the germination of /p/ and /b/ in these environments. It is argued in this paper that the germination is necessitated by the non-occurrence of both /p/ and /b/ between short vowels[7]; leading to the formulation of the constraint in (48).

48. $*V_{LAB}V$ ([–CONT], [–CG], [–NAS])

Avoid intervocalic labials specified for [–continuant], [–constricted glottis]

and [–nasal].

Examples of singleton [w] alternating with singleton [b] are found only in *laaw-ol/laab-i* 'road(s)' and *ɲiiw-a/ɲiib-i* 'elephant(s)'. These are not problematic because the singleton [b] is preceded by a long vowel in each of the examples. Alterations involving geminate [w] are not attested. This is because of a prohibition against geminate continuants. Similarly, alterations involving singleton /p/ and /b/ are not found. This is because only half of geminates and sonorants are attested coda consonants in the Sokoto dialect.

The data in (47c) show [n-d] alternating with geminate [l]; a process due to regressive assimilation caused by the constraint *n-l. In (47d) are examples of [n-d] alternating with singleton [l][8]. This is probably caused by the long vowel in the root which blocks the germination of [l] in such environments. The examples in (47e) show non-alternating [n-d] but [l]/[ll] and [ll]/[l] alternations are not found. However, [l]/[d][9] alternation is observed in words such as *bod-di/bol-le* 'snake(s)', *luud-e-re/duul-e* 'cloud(s)', etc.

[7] The opinion of Paradis (1992:52-53) on this differs. She notes (for Pulaar) that:

> Geminates themselves are also subject to a prohibition: they cannot be continuants, e.g. *ff, *rr, *ss, *ww, etc. ... When a continuant consonant must geminate, it automatically undergoes occlusivization, i.e. it loses its continuant feature (*ff - pp, *ww- bb, *yy - jj, etc.).

Breedeveld (1995:25-26) has yet a different opinion. Long consonants she observes, result from a fusion with a glottal stop which cannot occur next to a consonant. In his account, geminate /p/ in the plural of *lef-ol* 'strip' for example is derived through a combination of the stem-final /f/ and /ʔ/; thus, "lɛf+ʔi", *leppi* 'strips'. This argument is not supported in this dialect because one would expect the plurals of *kew-al* 'palm stalk', *buw-ol* 'road', *giif-ol* 'turban', etc. not to surface as *kew-i*, *buw-i* and *giif-i* but as **kebb-i*, **bubb-i* and **giipp-i*.

[8] A similar l/^{n}d alternation is reported in Dholuo, Kenya (Pulleyblank, 2006).

[9] In Setswana (Odden, 2005:50), /l/ and /d/ are allophones of a single phoneme).

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With the constraint in (48), the pair *how.ru/kop.pi* [how.ɾʊ/kop.pɪ] 'knee(s)' is used as representative of the two examples in (47a) and (47b) which are evaluated in (49).

49. Tableau for [how.ɾʊ] 'knee (SG.)'.

	/kof- + ɾʊ [+CONT]/	σ-CONT	IDENT-MANNER
	a. [hof.ɾʊ]	*!	
☞	b. [how.ɾʊ]		*
	c. [hop.ɾʊ]	*!	

In (49), the attested [how.ɾʊ] is selected as the optimal candidate because, although violating MANNER identity, it satisfies the undominated σ-CONT. The losing candidates (a) and (c), [hof.ɾʊ] and [hop.ɾʊ] both incur a fatal violation of syllable contact. The plural correspondent is examined in (50). For reasons of space, the constraint in (48) above is represented as $*V_{LAB}V$ in the tableau.

50. Tableau for [kop.pɪ] 'knee (PL.)'.

	/kof- + ɪ/	σ-CONT	$*V_{LAB}V$	IDENT-MANNER
	a. [ko p.ɪ]		*!	
	b. [ko p.pɪ]			*!
☜	c. [kof .fɪ]			
☜	d. [ko. fɪ]			

In (50), there are two invalid winners: candidates (c) and (d). Candidate (a) is removed by the constraint militating against intervocalic bilabials while the attested candidate (b) incurs a violation of MANNER. There is no constraint that eliminates candidate (c) with geminate [f]. Candidate (d) is the most faithful but is not the actual output. The sub-optimal candidate (c) has a geminate continuant [ff]. Data shows that geminate continuants are very rare[10]. For this reason, a constraint against geminate continuants is proposed in (51).

[10] Arnott (1970:42) equally observes that: "… nearly all single consonants have geminate counterparts; only ff, ww, ss, hh, and ŋŋ do not occur, though yy is confined to a few Hausa loan-words". Removing "ŋŋ" from the list, the remaining pairs are continuants. Recall from section 3.1.6 in chapter 3 however, that geminate ŋŋ occur in Sokoto Fula.

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51. *GEM-CONT

If geminate, then not [continuant].

Looking at candidate (d), [ko.fɪ] shows that it has a stop-initial and a continuant-final stem. Examining the data in (47) reveals a consistent pattern: whenever there is initial mutation and stem-alternation in a pair (specifically stop-continuant alternation), stem-initial and stem-final segments always bear identical continuant or non-continuant features (highlighted in the examples).

52. Stems with both mutation and alternation

Continuant		**Stop**	
rew-ɓe	[**ɾew**-ɓe]	*debb-o*	[**deb.b**o] ‘female(s)’
wuy-ɓe	[**w**ʊ**j**-ɓe]	*gujj-o*	[**g**ʊ**dʒ.dʒ**o] ‘thief/thieves’
yees-o	[**j**eː.**s**o]	*geec-e*	[**g**eː.**ʧ**e] ‘face(s)’
haay-re	[**h**ɑː**j**.ɾe]	*kaayƴ-e*	[**k**ɑː**ƴ**-e] ‘stone(s)’
faaw-ru	[**f**ɑː**w**.ɾʊ]	*paaɓ-i*	[**p**ɑː**ɓ**-ɪ] ‘frog(s)’
saw-ru	[**s**ɑ**w**.ɾʊ]	*cabb-i*	[**ʧ**ɑ**bb**-ɪ] ‘stick(s)’

The noun pair [how.ɾʊ/kop.pɪ][11] ‘knee(s)’ displays both mutation and alternation; hence it patterns with the examples in (47). With the foregoing examples, a constraint militating against the occurrence of segments bearing different [continuant] features in a stem is proposed. The constraint is argued for in Lombardi (1999) while its instantiation is found in Baković (2000, p.4), repeated in (53).

53. AGREE [F]

Adjacent segments must have the same value for the feature [F].

The constraint in (53) is *relativized* to feature [±continuant] in (54).

54. AGREE [±CONT]

Stem-initial and stem-final segments share identical [±continuant] features.

The constraint in (54) will remove candidate (d). The candidates in (50) are therefore re-evaluated against the additional constraints in the tableau in (55). The syllable contact constraint is removed from the tableau as no candidate violates it. IDENT-MANNER is represented as IDENT-M for reasons of space.

[11] Circumstances similar to those that make the *V-V constraints desirable in Sokoto Fula are reported in other languages as well. In Southern Paiute (Sapir 1930 in Kager, 2004:45), there is a prohibition against intervocalic labial glides in certain contexts and in Turkish, (Inkelas and Orgun, 1995), there is a prohibition against intervocalic k.

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55. Tableau for [kop.pɪ] 'knee (PL.)'

	/kof- + ɪ/	*V_{LAB}V	*GEM-CONT	AGREE [±CONT]	DEP-IO	IDENT-M
	a. [ko p.ɪ]	*!				
☞	b. [ko p.pɪ]				*	*
	c. [kof .fɪ]		*!	*!	*	
	d. [ko. fɪ]			*!		

The three higher-ranked constraints in (55) are not ranked with respect to one another because whichever way they are ranked; the same outcome will result.

The examples in (52c) are similar to those in (52a and b) but different circumstances lead to the formation of geminates in both. While in the former, geminates result from a prohibition against intervocalic /p/ and /b/, in the latter, gemination from regressive assimilation is induced by a prohibition against n-l sequences. Although, a constraint *n-l is reasonable to propose, it is subsumed under the syllable contact constraint in this paper because n-l sequences involve a rise in sonority which violates σ-CONT. In the tableau in (56), the plural counterpart of the pair *son-du/col-li* [son.dʊ/ʧol.lɪ] 'bird(s)' is analysed as representative of the set.

56. Tableau for [ʧol.lɪ] 'bird (PL.)'.

	/ʧon- + lɪ/	σ-CONT	IDENT-MANNER
	a. [ʧo n.lɪ]	*!	
☞	b. [ʧo l.lɪ]		*

In (56), the losing candidate incurs a fatal violation of syllable contact and is thus eliminated. The winning candidate circumvents such a violation through regressive assimilation, incurring a non-fatal violation of MANNER.

Syllables Violating Sonority Requirements

As noted in the preceding section, the majority of the syllables in the Sokoto dialect of Fulfulde conform to the *Syllable Contact Law*. The data in (57) however, show some examples that are in violation of the Law, i.e. those involving a rise in sonority (57b) alongside those with a sonority plateau (57a) which under the analysis adopted in this paper, are licit.

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57. Syllables with sonority plateau and sonority rise

(a.) **Sonority plateau**			(b.) **Sonority rise**		
Word	**Gloss**	**Alternative**	**Word**	**Gloss**	**Alternative**
[so**p**.**t**ɪ.ke] *sop-t-i-ke*	has got loose/free	[so**t**.**t**ɪ.ke] *sot-t-i-ke*	[wʊ**r**.**w**ɪ] *wurw-i*	stirred (soup)	***
[mo**ɓ**.**t**oɾ. de] *moɓ-t-or-de*	association/union	***	[wo**l**.**w**ɪ] *wolw-i*	spoke	***
[ɲɑː**m**.**n**ɪ] *ɲaam-ni*	fed	[ɲɑː**n**.**n**ɪ] *ɲaan-ni*	[fo**l**.**w**ɪː] *folw-ii*	woke up	***
[sɑ**r**.**l**ɑ] *sarl-a*	trousers	[sɑ**l**.**l**ɑ] *sall-a*	[dʊ**r**.**w**ɑl. dɪ] *durw-al-di*	type of bull	***
[ge**r**.**l**ɑl] *gerl-al*	bush fowl	[ge**l**.**l**ɑl] *gell-al*	[he**m**.**r**e] *hem-re*	hundred	***

The examples in (57a) which all have sonority plateaux (shown in bold) are instances of good syllable contact because of their flat sonority. This is in view of the reformulation of the *Syllable Contact Law* which requires that sonority should not rise over a syllable boundary. The alternative realisations, shown in the third column, which in the data for this research represent the majority, also show flat sonority. Such occurrences are therefore straightforward. There is however, an issue with the examples in (57b): they all have a sonority rise (shown in bold) in contravention of the Law. None of the items has a variant realisation. Similar manifestations of rising sonority also are found in other languages. Languages that are caught in these kinds of violations as the Sokoto dialect of Fulfulde reportedly resort to different restoration strategies with a view to improving the well-formed nature of their syllable structures. Korean, for example, appeals to two strategies to preserve its syllable structures in adherence to the *Syllable Contact Law*: nasalisation and n-lateralisation. See Davis and Shin (1999) for a full discussion. Chaha, an East African language (Rose, 2000) is replete with many attested syllable forms that violate the *Syllable Contact Law* (see Rose 2000 for examples). However, there are examples in which an epenthetic [ɨ] breaks up illicit clusters to ensure an acceptable syllable contact.

Japanese, Ponapean and Diola-Fogny (Kager, 2004) resort to three processes through which they improve their syllable well-formedness. These are Place Assimilation, Epenthesis and Consonant Deletion shown in the ruled-based notations in (58).

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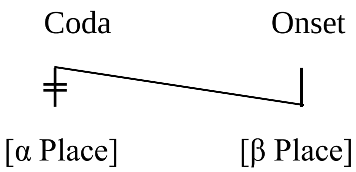
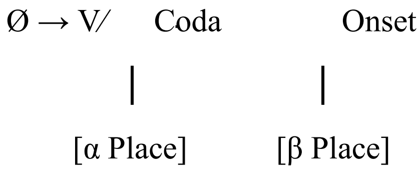
58. Japanese, Ponapean and Diola-Fogny syllable repair strategies (Kager, 2004, p.139).

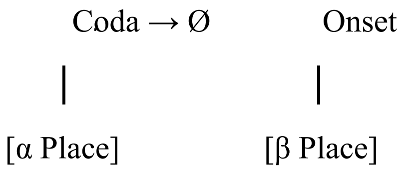
a. Japanese: Place Assimilation:



b. Ponapean: Vowel Epenthesis:



c. Diola-Fogny Consonant Deletion:



These strategies are also employed in the Sokoto dialect of Fulfulde. The fact that the faithfulness constraints MAX-IO and DEP-IO are violable in this dialect of Fulfulde provides sufficient evidence for these processes. These approaches however, still leave unresolved, the challenge posed by examples in (57b). Nevertheless, since constraints must be grounded (Archangeli & Pulleyblank 1994; Kager 1999), an explanation should be provided as to why these syllables behave the way they do in Sokoto Fulfulde.

Looking closely at the data in (57b) shows that some aspects of Sokoto Fulfulde syllabification pattern like that of Latin (Cser, 2012, p.51) in which "Heterosyllabic, i.e. coda–onset, clusters in Latin simplex forms are overwhelmingly in conformity with the Syllable Contact Law" whereas those with a sonority rise obey the *The Inverse Place Condition* (Cser, 2012, p.52) reproduced in (59).

59. *The Inverse Place Condition*

Heterosyllabic clusters consisting of non-nasal sonorants are well-formed irrespective of sonority relations if C1 is coronal and C2 is non-coronal (i.e. [lw rw jw] are well-formed). If C2 is coronal, only sonority relations are decisive (i.e. [wr wl jr jl] are well-formed, *[rl lr lj rj wj] are not).

The examples in (57b), except the last example, have either [lw] or [rw] clusters and are consequently subject to the condition in (59). This all the same, still leaves some issues unresolved. One is that the condition rules out *r-l which are attested in words like *gerl-al*

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'francolin'. Similarly, *hem-re* [hem.ɹe] 'hundred', with an m-r combination that violates syllable contact, calls for explanation.

A further look reveals that a lot of syllable contact relations are grounded on sonority hierarchy, with scholars making reasonable representations of the hierarchical order of sounds with respect to syllabification. See for example Zec (1995), Parker (2012), Baertsch (2012), Smith and Moreton (2012), van de Vijver and Baer-Henney (2012), etc. In this paper, the proposal of Jespersen (1904) in Gouskova (2004, p.208) is reproduced in (60).

60. The Sonority Scale

glides > rhotics > laterals > nasals > voiced fricatives > voiced stops >

voiceless fricatives > voiceless stops (i.e. w > r > l > n > z > d > s> t).

Gouskova (2004) appeals to the concept of *Harmonic Alignment* (see also Prince & Smolensky 1993; 2004) which she develops in the discussion of syllable contact phenomena in five languages: Faroese, Icelandic, Kazakh, Kirghiz and Sidamo and brings forth a *Harmonic Scale* represented in (61)

61. a. Onset sonority scale

Ons/t > Ons/s > Ons/d > Ons/z > Ons/n > Ons/l > Ons/r > Ons/w

b. Coda (mora) sonority scale

μ/w > μ/r > μ/l > μ/n > μ/z > μ/d > μ/s > μ/t

The scale in (61a) shows a predilection towards obstruent onsets and the one in (61b), an inclination towards sonorant codas. This is aptly captured in Gouskova (2004, p.202) who suggests that "no language requires that sonority rise **between an onset and the following coda** (favouring [ap.la] over [ap.ta] say) or bans sonority from falling (favouring [ap.ta] over [an.ta])" (emphasis added because the statement is read as "**between a coda and the following onset"** rather than "between an onset and the following coda"). However, this is exactly what is seen in the examples in (57b).

Gouskova (2004) notes that although the *Syllable Contact Law* requires segments occurring next to each other to vary by a given number of levels of ordering, exactly "how much sonority must fall varies from language to language" She therefore looks at syllable contact in terms of *relational hierarchies* and proposes a *relational scale* which places all possible coda/onset combinations on a level in a given stratum.

62. Relational Scale for codas and onsets (Gouskova, 2004).

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
w.t >	w.s >	w.d >	w.z >	w.n>	w.l>	w.r>	w.w>	r.w>	l.w >	n.w >	z.w >	d.w >	s.w >	t.w
	r.t	r.s	r.d	r.z	r.n	r.l	r.r	l.r	n.r	z.r	d.r	s.r	t.s	
		l.t	l.s	l.d	l.z	l.n	l.l	n.l	z.l	d.l	s.l	t.l		
			n.t	n.s	n.d	n.z	n.n	z.n	d.n	s.n	t.n			

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				z.t	z.s	z.d	z.z	d.z	s.z	t.z				
					d.t	d.z	d.d	s.d	t.d					
						s.t	s.s	t.s						
							t.t							
- 7	- 6	- 5	- 4	- 3	- 2	- 1	0	+1	+2	+3	+4	+5	+6	+7

The scale, ranging from –7 at the start of the continuum and +7 at the end, with 0 in-between implies that every language chooses a cut-off point for its licit segment combinations along the continuum. She shows that constraints that are highest-ranking on the scale disfavour structures of codas and onsets that have a high level of rise in sonority. On the contrary, constraints that are lowest-ranking rule out sequences that have the highest level of fall in sonority. She names these constraints *DISTANCE $_X$ ((DIST $_X$) "since each constraint bans a stratum with a particular sonority distance x" (p.211).

The above schema is relevant because it provides a basis for explaining, in relation to what obtains in other languages, the Sokoto Fulfulde syllabification processes that violate the *Syllable Contact Law*. From the description, the data in (63) is a representation of instances where this dialect allows a sonority drop.

63. Drop in Sonority

a.	*wur.tii*	[wʊ**r.t**ɪː]	–5	'went out'
b.	*hol.ti.ni*	[ho**l.t**ɪ.nɪ]	–5	'bought cloth for someone'
c.	*ol.ki*	[o**l.k**ɪ]	–5	'made loud noise'
d.	*fer.gii*	[fe**r.g**ɪː]	–4	'tripped off'
e.	*ŋal.fo*	[ŋɑ**l.f**o]	–4	'play-fighting'
f.	*war.di*	[wɑ**r.d**ɪ]	–4	'came along with'
g.	*dam.pi*	[dɑ**m.p**ɪ]	–4	'shot (with foot)'
h.	*ɓan.ti*	[ɓɑ**n.t**ɪ]	–4	'raised'
i.	*dum.fu*	[dʊ̃**ɱ.f**ʊ]	–3	'all of it'
j.	*yar.ni*	[jɑ**r.n**ɪ]	–2	'made to drink'
k.	*an.di*	[ɑ**n.d**ɪ]	–2	'knew'
l.	*wel.ma*	[we**l.m**ɑ]	–1	'pleasingly'
m.	*gas.ka*	[gɑ**s.k**ɑ][12]	–1	'hole'

To recapitulate, majority syllables in the Sokoto dialect of Fulfulde conform to the *Syllable Contact Law* (Vennemann, 1988) because preceding codas are more sonorous than following onsets. A definite statement about Sokoto Fulfulde syllabification based on the above data can now be made. It is equally possible to determine what choices the dialect makes in terms of cut-off points on the sonority scale as in (64).

[12] Only a few speakers used this form. Majority produced *gay.ka* [gɑj.kɑ].

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64. Sokoto Fulfulde sonority scale

rise flat drop

. . . *D +5 >>*D +4 >> *D +2 >> *D +1 >> *D 0 >> *D – 1 >> *D – 2 >> *D – 3 >>*D– 4....

↑ ↑ ↑ ↑

Fulfulde Fulfulde Fulfulde Fulfulde

The scale indicates that syllabification in the Sokoto dialect of Fulfulde employs several sonority combinations on the scale except at the two extremes. The dialect allows a rise in sonority to a maximum of +3 points. On that basis, [w.ɾ] with +1, e.g. [wʊɾ.wɪ] ‘stirred (soup)’, [l.w] with +2, e.g. [wol.wɪ] ‘spoke’; and [m.ɾ] with +3, e.g. [hem.ɾe] ‘hundred’ are well-formed. In syllable contact situations therefore, any sonority rise that is above +3 is not permitted. Flat sonority is also allowed and this, if viewed from the interpretation of the *Syllable Contact Law*, is acceptable. A drop in sonority is equally permitted in the language as is evident from the many examples cited in (63). However, there is a ceiling to the degree; sonority must not drop below – 5.

What the foregoing discussion suggests is that although the syllable contact constraint is violable in the Sokoto dialect of Fulfulde, no single constraint can adequately handle all the properties exhibited by its syllable structures. Except for the rising sonority examples, σ-CONT is satisfactory in accounting for medial cluster syllabification. In sum, syllabification in the Sokoto dialect of Fulfulde appears to be accounted for by 19 constraints in 3 tiers as shown in (65). A final tableau showing the effect of all the constraints is given in (66).

65. $*COMPLEX^{ONSET}$, NUC, ONSET, PARSE, σ-CONT, *h] σ, $*V_{LAB}V$

([–CONT], [–CG], [–NAS]), *GEM-CONT, AGREE [±CONT], *l-r, MAX-μ >> MAX-IO, DEP-IO, DEP-μ-IO >> IDENT-MANNER, IDENT-IO [PLACE], NO-CODA, $*COMPLEX^{CODA}$

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Constraints: *COMPLEX^{ONSET}, NUC, ONSET, PARSE, σ-CONT, *h] σ, *V$_{LAB}$V ([–CONT], [–CG], [–NAS]), *GEM-CONT,

AGREE [±CONT], *l-r, MAX-μ >> MAX-IO, DEP-IO, DEP-μ-IO >> IDENT-MANNER, IDENT-IO [PLACE], NO-CODA, *COMPLEX^{CODA}.

66. Tableau for [ʧɪp.po:.ɓe] 'those that sell (something)'.

	/ʧɪppo:ɓe/	*Cx^{O}	Nuc	Ons	Prs	σ-C	*h]σ	*V$_{L}$B	*G-C	Agr	*l-r	M-μ	M-I	D-I	D-μ	I-M	I-P	NC	*Cx^{C}
☞	a. [ʧɪp.po:.ɓe]																	*	
	b. [ʧɪ.ppo:.ɓe]	*!																	
	c. [ʧɪ.p.po:.ɓe]		*!																
	d. [ʧɪpp.o:.ɓe]			*!															*
	e. [ʧɪp̱.po:.ɓe]				*!														
	f. [ʧɪp.jo:.ɓe]					*!										*	*	*	
	g. [ʧɪh.po:.ɓe]						*!									*	*	*	
	h. [ʧɪ.po.ɓe]							*!				*!	*!						
	i. [ʧɪf.fo:.ɓe]								*!									*	
	j. [ʧɪf.po:.ɓe]									*!						*	*	*	
	k. [ʧɪl.ro:.ɓe]										*!							*	
	l. [ʧɪ.po:.ɓe]											*!	*!						
	m. [ʧɪ:p.po:.ɓe]													*!	*!			*	

DISCUSSION AND CONCLUSION

In the analysis of Sokoto Fulfulde syllabification in this paper, it is seen that the core syllable is the CV type following a high-ranking ONSET constraint. Complex onsets are disallowed but complex codas are allowed in word-medial positions. The analysis brings to light the fact that although simple syllabification may be handled by the five *markedness* constraints governing syllabification, the constraints must interact with *faithfulness* constraints in order to handle the syllabification of complex stem alternations.

The syllable contact-compliant nature of Sokoto Fulfulde syllables engender the adoption of strategies to repair illicit syllable contact. However, in comparison with other languages, no single syllable repair strategy resorted to by other languages works adequately for this dialect of Fulfulde. This is because whereas the majority of syllables are syllable contact-compliant, a few can only be handled through the *Inverse Place Condition* (Cser, 2012) and *Relational Hierarchies* (Gouskova, 2004), since the dialect tolerates different types of sonority dispersion. It permits sonority rise as well as sonority drop in addition to flat sonority.

The discussion of syllabification finally suggests that the *Sonority Hierarchy* is inadequate in explaining the pattern of syllabification found in the Sokoto dialect of Fulfulde. This is because whereas most syllables conform to the *Syllable Contact Law* (Vennemann, 1988) a few others do not; a suggestive piece of evidence that the grammar is basically syllable contact-compliant, with a few exceptions. Syllables displaying a rise in sonority like [hem-ɾe] 'hundred', [dʊɾ.wɑl.dɪ] 'a type of cow', [wʊɾ.wɪ] 'stirred (something)' and [fol.wɪ:] 'woke up (from sleep)' are left "unrepaired". In contrast, other instances of sonority rise attract repair strategies: examples include /woɓ.ru/ → [wow.ɾʊ] 'mortar', /taʄ.re/ → [tɑ:j.ɾe] 'a slice of meat', /doomb.ru/ → [do:w.ɾʊ] 'rat', etc. calling for a language-specific Fulfulde sonority hierarchy.

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