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The Phonology of Geminates in Bedouin Hijazi Arabic: An Optimality Theoretic Approach

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Abstract

This paper examines the phonology of geminates in Bani Sulaim dialect, BSD, a Bedouin Hijazi dialect spoken in Saudi Arabia, within Optimality Theory framework, OT. The analysis covers lexical geminates, phonologically derived geminates through assimilation, and gemination as a compensatory strategy to compensate for lost mora after vowel deletion. The paper explores the interaction between vowel deletion, assimilation, and compensatory lengthening. In BSD, lexical geminates are phonemically contrastive with singletons in word medial and word final positions, while phonologically derived geminates are found in word initial and word final positions through assimilation. Using OT constraints, ranking the markedness constraints, that disallow certain consonant clusters in the output, higher than the faithfulness constraints shows that phonotactically prohibited consonant clusters are avoided through total assimilation that results in gemination. The final phonological process that generates geminates in BSD is a form of consonant lengthening to adhere to the moraic weight requirement of the dialect. In addition to presenting new data, this paper contributes to the sparse literature on geminates in Bedouin dialects.

1. INTRODUCTION

Gemination is phonemic in Arabic language. A geminate is regarded as a long consonant compared to only a single consonant (Davis 2011). An example of the difference between the two is found in Saudi Arabic where the word [sa.lam] 'a type of tree' is different from the word [sal.lam]. Geminates have been the focus of many studies across different dialects of Arabic from phonetic and phonological perspectives (e.g. Davis 1999a; 1999b; Ringen and Vago 2010; Al-Tamimi, Abu-Abbas, and Tarawnah 2010; Davis 2011; Davis and Ragheb 2014).

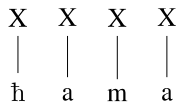
Phonetically, studies showed that a geminate is longer in duration compared to its singleton counterpart. The manner of articulation of geminated consonants is reported to be a factor influencing the importance of duration as a phonetic cue for the contrast between geminates and singleton consonants (e.g. Ghalib 1984; Lahiri and Hankamer 1988; Local and Simpson 1999; Tserdanelis and Arvaniti 2001; Ladd and Scobbie 2003; Blevins 2004; Payne 2005; Ridouane 2007; Khattab and Al-Tamimi 2014).

Phonologically, the representation of geminates is a point of discussion in the literature. Two approaches of geminate representation are the skeletal approach and the moraic approach.

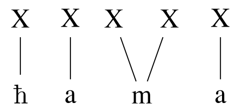
In each of the two approaches, geminates are treated differently in how they are linked to the prosodic tier.

In the skeletal approach, a geminate is considered a single long segment that is linked to two slots prosodically. These slots are referred to as X slots (McCarthy 1979, 1981; Clements and Keyser 1983; Levin 1985). A singleton consonant, on the other hand, is associated with only one slot, as illustrated in (1) in the examples [ħa.ma] 'he protected' in (a), and [ħam.ma] 'he heated' in (b). In (1a), [m] on the melody tier is linked to a single slot, whereas a geminate takes two slots (1b). The skeletal approach does not indicate weight, unlike the moraic approach discussed below.

(1) a. [ħa.ma]



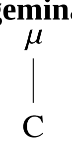
b. [ħam.ma]



The other approach of geminate representation is based on the moraic theory (Davis, 1999a; Hayes, 1986, 1989b; McCarthy & Prince, 1995). Within this theory, the lowest level is the mora level. The mora refers to segment weight regardless of its size. Based on this, a geminate is inherently heavy, as in (2a), and it is not associated with a double link as in the skeletal approach, while a single consonant is not inherently heavy in Arabic, as in (2b), and it gets a mora through due to its position, which discussed in the following paragraph.

(2) From (Hayes, 1989b)

a. Underlying geminate weight



(geminate)

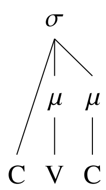
b. Underlying single consonant weight

C

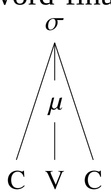
(singleton)

In many dialects of Arabic, a syllable final geminate is inherently heavy, while a syllable final single consonant is subject to extrametricality parameters (Liberman and Prince 1977; Nanni 1977; Hayes 1979, 1982, 1995), where a specific prosodic element is invisible to rule applications. A syllable final single consonant is assigned a mora through weight by position principle, WBP (Hayes 1989b, 258, 1995, 52), as in (3a). WBP can be blocked by extrametricality, as in (3b). A syllable final geminate, on the other hand, is always heavy and does not acquire weight through WBP and, therefore, is not affected by extrametricality.

(3) a. CVC in word-medial position



b. CV<C> in word-final position



The difference in moraic weight between a word final CVG syllable, G = geminate, and a word final CVC syllable is attested in stress patterns. A word final CVG syllable attracts stress, unlike a word final CVC syllable, as in (4).

(4)	a. word final CVG syllable		b. word final CVC syllable	
	[ma.sˤább]	'outlet'	[má.sak]	'he grabbed'
	[dab.báss]	'he stapled'	[dá.bas]	'molasses'

The source of geminates in Arabic dialects can be lexical or derived by either the phonology or the morphology (e.g. McCarthy 1981; Abu-Salim 1982). Lexical geminates are underlyingly contrastive, as in (5a). Phonologically derived geminates result mainly from assimilation, as in (5b). Morphologically derived geminates are triggered in verbs in the causative aspect, as in (5c), and in nouns in the instrumental form, as in (5d).

(5)	a. Lexical geminates		
	/matˤabb/	[ma.tˤabb]	'speed bump'
	/makabb/	[ma.kabb]	'dumpster'
	/saff/	[saff]	'ate'
	b. Assimilation		
	/ʔal-sabat/	[ʔas.sabt]	'the Saturday'
	/ʔal-darb/	[ʔad.darb]	'the way'
	/ʔal-nafs/	[ʔan.nafs]	'the soul'
	c. Causative verb		
	[ka.tab] 'write'	[kat.tab]	'cause to write'
	[ra.kab] 'climbed on'	[rak.kab]	'cause to climb'
	[ka.sab] 'profited'	[kas.sab]	'cause to profit'
	d. Instrumental nouns		
	[fa.laħ] 'succeeded'	[fal.la:ħ]	'farmer'
	[ka.ðab] 'lied'	[kað.ða:b]	'a liar'
	[ʁa.sal] 'washed'	[ʁas.sa:l]	'a washer'

In light of the above discussion of geminates, the aim of this paper is to examine the geminates in a Bedouin Hijazi dialect, Banu Sulaim dialect, henceforth BSD. BSD is spoken in the rural areas of Hijaz region in Saudi Arabia, mainly in an area called Wadi Starah, Starah valley. The focus will be on lexical geminates and phonologically derived geminates. Morphologically derived geminates will not be examined. The morphologically derived geminates in BSD require examining the morphology of verbs and nouns in the dialect which is complicated and involves other phonological processes, such as vowel deletion and epenthesis. Taking on this task in the same paper as phonologically derived geminates can be quite lengthy. So, to avoid this, I will leave the morphological part of geminates for future research.

The paper is has the following structure. Section 2 discusses data collection method and analysis. In section 3, the distribution of geminates in BSD is examined. Section 4 describes the origins of geminates in BSD, namely lexical and phonological geminates. This is followed by the conclusion in section 5.

2. Data collection and analysis

The data collection method in this study was based on two main steps. First, data were collected by the researcher from the speech of four native speakers of BSD, two males and two females between the ages of 45 and 71. Then, a list containing geminates in different word positions was compiled from the first step. Finally, the validity of this list was then verified in consultation with the speakers from the first step.

The analysis of data is done within Optimality Theory, OT. OT as a framework includes a set of universal violable faithfulness and markedness constraints that are ordered according to the grammar of the language to allow/disallow certain structures in the output. The interaction between faithfulness and markedness constraints in terms of ranking and dominance result in either a faithful or unfaithful mapping between the input and the output.

3. Distribution of geminates in BSD

Cross-linguistically, geminates are found in word initial, word medial, or word final positions. Peripheral geminates, i.e. word initial and word final geminates, are less common compared to word medial ones with intervocalic position being the most favorable position of geminates in languages (Thurgood 1993; Pajak 2013; Davis and Topintzi 2017; Ridouane and Turco 2019; Noamane 2020).

Some languages allow geminates to occur in all positions, such as Moroccan Arabic (Noamane 2020, 41) and Tashlhit (Bensoukas 2001, 123). Other languages, on the other hand, restrict the occurrence of geminates to certain positions, e.g. medial position in Italian (Curtis 2003: 72).

In Arabic dialects, geminates in word initial position are less common than word medial and word final geminates. Word initially, geminates result from assimilation and vowel deletion (Khattab and Al-Tamimi 2014, 238; Ridouane and Turco 2019, 65; Noamane 2020, 41), as in (6).

(6) Word initial geminates

a. from total assimilation in Moroccan Arabic (Ridouane and Turco 2019, 65; Noamane 2020, 41)

[ssaf] ‘the hawk’
[mm^{w}i] ‘my mother’

b. from vowel deletion in BSD

/ti-tabbin/ → [ttab.bin] ‘she marinates’
/ti-tarrdʒim/ → [ttar.dʒim] ‘she translates’

Word medial geminates are common in Arabic dialects, e.g. Palestinian Arabic (Abu-Salim 1982), Cairene Arabic (Hayes 1995), Makkan Arabic (Kabrah, 2004), Lebanese Arabic (Khattab and Al-Tamimi 2014), and Ruwaili Bedouin dialect (Al Solami 2020). In BSD, word medial geminates are possible intervocalically, as in (7).

(7) a. Intervocalic geminate CVG in BSD

[lam.mat] ‘she gathered’
[haf.fat] ‘she blew’
[sam.ma] ‘he named’

b. Intervocalic geminate CV:G in BSD

[la:m.mah] ‘gathered’
[ʃa:m.mah] ‘smelling (sg. fem.)’

[ga:m.mah]	'hoarding (sg. fem.)'

Word final geminates occur in different Arabic dialects as well, e.g. Baghdadi Arabic (Blanc, 1964), Hadrami Arabic (Bamakhramah, 2009), and Ruwaili Bedouin dialect (Al Solami, 2020). In BSD, word final geminates are also possible, as in (8).

(8) Word final geminates in BSD

[kumm]	'sleeve'
[famm]	'mouth'
[ma.tˤabb]	'speed bump'
[ma.ħall]	'a shop'
[da:ff]	'pushing'
[ʕa:mm]	'general'

To summarize, geminates in BSD can be found in word initial, word medial, and word final positions. However, word initial geminates result from assimilation and vowel deletion. These points are discussed further in the next section.

4. The source of geminates in BSD

Geminates in BSD can be lexical and can be derived by the phonology. These different types of geminates are discussed in what follows.

4.1. Lexical geminates

A Geminate in BSD contrasts with its singleton counterpart and triggers difference in meaning. Therefore, the difference between geminates and singleton consonants is phonemic, as can be established by the minimal pairs in (9). This contrast is found only word medially and word finally.

(9) Geminates vs singleton consonants in BSD

a. Word medial geminates

[sa.lam]	'type of tree'	[sal.lam]	'he saluted'
[sa.ma]	'sky'	[sam.ma]	'he named'
[ma.rah]	'lady'	[mar.rah]	'once'
[ħa.ma:m]	'pigeons'	[ħam.ma:m]	'bathroom'
[ha.da]	'guided'	[had.da]	'slowed down'
[ħa.ma]	'defended'	[ħam.ma]	'heated'
[ʔa.mar]	'ordered'	[ʔam.mar]	'appointed a leader'
[ʕa.lam]	'a flag'	[ʕal.lam]	'taught'
[ʕa.bar]	'crossed'	[ʕab.bar]	'explained'
[ʕa.dʒal]	'tire'	[ʕadʒ.dʒal]	'rushed'
[ga.mar]	'moon'	[gam.mar]	'toasted'
[ba.rad]	'hail'	[bar.rad]	'to cool'

b. Word final geminates

[sa:m]	'he estimated'	[sa:mm]	'poisonous'
[ħa:r]	'confused'	[ħa:rr]	'hot'
[tˤa:b]	'got well'	[tˤa:bb]	'jumping in'
[ʕa:m]	'year'	[ʕa:mm]	'public'
[la:m]	'blamed'	[la:mm]	'gathered'
[dʒa:r]	'neighbor'	[dʒa:rr]	'dragging'

[ʃa:m]	'north'	[ʃa:mm]	'smelling'
[sˤa:d]	'hunted'	[sˤa:dd]	'ignoring'
[ʁa:ʃ]	'boiled'	[ʁa:ʃʃ]	'cheating'

The geminates in (9) are phonemic and surface unchanged. Within OT framework, this is obtained by avoiding violating the faithfulness constraint Max (Prince & Smolensky, 2004), given in (10). The constraint in (10) militates against any segmental deletion on the surface, which is ranked higher than the markedness constrains *GEM, which is violated by surface geminates. The constraint in (10) is exemplified in the tableau in (11).

(10) a. Max-G
Every geminate in the input has a correspondent in the output.

(11) Phonemic status of geminates

/ħamma/ 'heated'	Max-G	*GEM
☞a. [ħam.ma]		*
b. [ħa.ma]	*!	

The tableau in (11) suggests that the faithfulness constraint Max-G should outrank the markedness constraint *GEM, which disallows a surface geminate, Max-C >>*GEM.

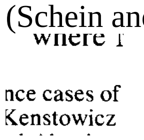
In BSD, as well as in many Arabic dialects (e.g. Al-Tamimi, Abu-Abbas, and Tarawnah 2010; Alhuwaykim 2018; Noamane 2020), geminates are not allowed to be split by epenthesis, as in (12). This is referred to as geminate integrity where geminates cannot be split by an epenthetic vowel and geminates are considered as a single segment.

(12)

/lamm/	[lamm]	*[la.mim]	'collected'
/hamm/	[hamm]	*[ha.mim]	'worry'
/simm/	[simm]	*[si.mim]	'poison'
/da:bb/	[da:bb]	*[da:.bib]	'snake'

The notion that the structure of geminates is not allowed to be split by epenthesis is referred to as the Adjacency Identity Constraint (Kenstowicz and Pyle 1973; Guerssel 1978; Schein and Steriade 1986; McCarthy and Prince 1986; Curtis 2003; Blevins 2004). Geminates resist being split by a vowel that crosses association lines with the geminate segment, as in (13).

(13) (Schein and Steriade 1986, 692)


where I
nce cases of
Kenstowicz

The integrity of geminates in BSD can be ensured through the constraint in (14), which is exemplified in (15).

(14) IDENT-IO[GEM] (Kenstowicz, 1995)
Output correspondents of an input [Gem] are also [Gem].

(15)

/rabb/ 'god'	IDENT-IO[GEM]
☞ a. [rabb]	
b. [ra.bib]	*!

In BSD, geminates are never split by an epenthetic vowel between them. However, when a geminate is followed with a consonant initial suffix, a vowel is inserted after the geminate to avoid a contained geminate. A contained geminate is a geminate that occurs within a syllable (Curis 2003: 303), as illustrated in (16).

(16)	/kumm-ha/	[kum.m**a**.ha]	*[kumm.ha]	‘her sleeve’
	/ʕamm-na/	[ʕam.m**a**.na]		‘our (paternal) uncle’
	/daff-ha/	[daf.f**a**.ha]		‘he pushed her’
	/laff-ha/	[laf.f**a**.ha]		‘he twisted it (fem.)’
	/ʕa:mm-na/	[ʕa:m.m**a**.na]		‘including all of us’
	/da:bb-na/	[da:b.b**a**.na]		‘our snake’

The geminates in (16) are not allowed to occur contained in a syllable in word medial position. The output shows that they are repaired through epenthesis. Other Arabic dialects deal with contained geminates differently. In Northwestern Saudi Arabia dialect (Alhuwaykum 2018) contained geminates are preserved and are allowed to surface without repair. In other Arabic dialects, contained geminates are repaired through degemination, which involves deleting the second segment of the geminates (Abu-Abbas 2003). In such dialects, the geminate in /ʕamm-kum/, for example, would surface as [ʕam.kum] after degemination.

The prohibition of contained geminates in BSD is in line with the overall prohibition of complex clusters in coda position in medial position, as in (17).

(17)	/ʕind-ha/	[ʕin.d**a**.ha]	‘with her’
	/rumħ-ha/	[rum.ħ**a**.ha]	‘her spear’
	/gidr-na/	[gid.r**a**.na]	‘our pot’

The avoidance of contained geminates and consonant clusters through epenthesis in BSD, and not through other strategies, such as degemination, result from the interaction between the faithfulness constrains Max-G, which militates against geminate deletion, and the markedness constraint that prevents complex codas from surfacing, in (18). This is exemplified by the tableau in (19).

(18) *COMPLEXCoda (Kager 1997)
Complex codas are not allowed.

(19)

/kumm-ha/ ‘her sleeve’	Max-G	*GEM	*COMPLEXCoda
a. [kum.ha]	*!		
b. [kumm.ha]		*	*!
☞ c. [kum.ma.ha]		*	

Candidate (19a) shows the degemination process found in other dialects. It is ruled out since it incurs a fatal violation of the high ranked Max-G. Candidate. (19b) is the faithful candidate, but it is also excluded because it has the unwanted contained geminate, and it incurs a violation of the constraint prohibiting complex codas. Finally, candidate (19c) is the optimal candidate that preserves the underlying geminate and avoids the complex coda through epenthesis.

In addition to lexical geminates, BSD has phonologically derived geminates that result from assimilation, vowel deletion and from prosodic weight requirement. These different points are discussed in the following sections.

4.2. Phonologically derived geminates

4.2.1. Gemination due to assimilation

A strategy for deriving geminates in BSD is the assimilation of the lateral segment of the definite article /ʔal-/ to a following coronal in root initial position. This strategy is very common in Arabic dialects and is widely cited in the literature as the sun /l/ and the moon (lunar) /l/. It has been reported in Palestinian Arabic (Abu-Salim 1980, 9); Standard Arabic (Kenstowicz 1994, 52), San'ani and Cairene Arabic (Watson 2002, 217), Libyan Arabic (Elramli 2012, 61), Qassimi Arabic (Alqahtani 2020, 351) , Moroccan Arabic (Noamane 2020, 50), and Bedouin dialects (Al Solami 2020, 78).

In this assimilation process in BSD, the lateral /l/ of the definite article /ʔal-/ assimilates to match the features of a root initial coronal segment, as illustrated by the following examples in (20a). A root initial segment that is not coronal, however, does not trigger assimilation, as in (20b).

(20) a. Geminates arising due to concatenation of /ʔal-/

/ʔal-sabt/	[ʔas.sabt]	'the Saturday'
/ʔal-sˤo:m/	[ʔasˤ.sˤo:m]	'the fasting'
/ʔal-darb/	[ʔad.darb]	'the way'
/ʔal-rafʕ/	[ʔar.rafʕ]	'the raising'
/ʔal-na:r/	[ʔan.na:r]	'the fire'
/ʔal-no:m/	[ʔan.no:m]	'the sleep'

b. non-assimilating examples

/ʔal-kalb/	[ʔal.kalb]	'the dog'
/ʔal-galb/	[ʔal.galb]	'the heart'
/ʔal-ʁanam/	[ʔal.ʁanam]	'the sheep'
/ʔal-karam/	[ʔal.karam]	'the generosity'
/ʔal-hadaf/	[ʔal.hadaf]	'the goal'

The following constraints in (21) are needed to account for the assimilation process in (20a) between the definite article and the following coronal. The tableau in (22) shows the order of these constraints.

(21) a. AGREE-(Coronal) (Lombardi, 2001; McCarthy, 2011)
The feature value of the preceding/following coronal segments are identical.

b. IDENT-IO (F) (McCarthy and Prince 1995)
Corresponding segments in input and output must have identical feature values.

c. IDENT-RtC_1 (Loutfi, 2016) (C_1 refers to the first consonant of the root) An input feature specification in the first segment of the root and its output correspondent must be identical.

(22)

/ʔal-sabt/ 'Saturday'	AGREE-(Coronal)	IDENT-IO (F)	IDENT-RtC_1
a. [ʔal.sabt]	*!		
☞ b. [ʔas.sabt]		*	
c. [ʔal.labt]		*	*!

The constraint AGREE-(Coronal) requires identical feature values of adjacent coronal segments. This constraint penalizes candidate (22a), which is the faithful candidate, because the coronal feature is not identical between the preceding /l/ and the following /s/ segments. The faithfulness constraint IDENT-IO (F) penalizes any change to the input. Both candidates (22b) and (22c) violate this constraint due to assimilation. The difference between the optimal candidate in (22b) and the candidate in (22c) is in assimilation direction. As suggested by the optimal candidate in (22b), the final segment of the definite article assimilates to the following root initial segment. Prioritizing the root initial segment is required by the constraint IDENT-RtC$_1$, which is violated by candidate (22c) because the final segment of the prefix is prioritized.

The examples in (20b) begin with a non-coronal segment and no assimilation takes place. In this case, the constraint AGREE-(Coronal) does not apply since its conditioning environment is not met, and therefore it is not violated by any candidate, as in the tableau in (23).

(23)

/ʔal-kalb/ 'the dog'	AGREE-(Coronal)	IDENT-IO (F)
a. [ʔak.kalb]		*!
☞ b. [ʔal.kalb]		
c. [ʔal.lalb]		*!

The faithful candidate in (23b) is the winner since it does not incur any violations of the input. Candidates (23a) and (23c), on the other hand, show assimilation in different directions and both incur a violation of the faithfulness constraint IDENT-IO (F).

Vowel deletion can trigger a different type of assimilation process that results in gemination in BSD. In BSD, as in many other Bedouin dialects (see Al Solami 2020), high short non-final vowels in open syllables are deleted, as in (24), which is referred to as high vowel deletion, HVD.

(24) HVD in BSD

/kita:b/	[kta:b]	'a book'
/bila:d/	[bla:d]	'farm'
/siba:b/	[sba:b]	'cursing'
/ʃubu:k/	[ʃbu:k]	'fences'
/ʕugu:m/	[ʕgu:m]	'dirt barrier'
/ruχu:m/	[rχu:m]	'cowards'

As shown in (24), the high short vowels /i/ and /u/ are deleted because they occur in an open syllable in non-final position. To deal with HVD in (24), the constraint in (25) is implemented. The constraint in (25) militates against the occurrence of vowels /i/ and /u/ in open syllables in non-final position.

(25) *i]$_\sigma$ (Kenstowicz, 1995)
High short non-final vowels in open syllables are not allowed.

The following tableau in (26) shows that the markedness constraint *i]$_\sigma$ outranks the faithfulness constraint IDENT-IO [V], which is violated by vowel deletion. Candidate (26a) is the optimal candidate since it avoids violating the dominating markedness constraint *i]$_\sigma$.

(26)

/kita:b / 'a book'	*i]$_\sigma$	IDENT-IO[V]
☞ a. [kta:b]		*
b. [ki.ta:b]	*!	

The examples in (24) show that HVD results in word initial consonant clusters. HVD can also result in word initial geminates due to assimilation between the prefix and root initial segment. Consider the examples in (27).

(27)	/ti-dabbir/	[ddab.bir]	'she/ you (sg. masc.) deal with'
	/ti-darrik/	[ddar.rik]	'she/ you (sg. masc.) grab tightly'
	/ti-dʒi:b/	[dʒdʒi:b]	'she/ you (sg. masc.) bring'
	/ti-dʒammiʕ/	[dʒdʒam.miʕ]	'she/ you (sg. masc.) gather'
	/ti-da:fiʕ/	[dda:.fiʕ]	'she/ you (sg. masc.) defend'
	/ti-dahhin/	[ddah.hin]	'she/ you (sg. masc.) smear'
	/ti-ðu:g/	[ððu:g]	'she/ you (sg. masc.) taste'
	/ti-ðu:b/	[ððu:b]	'she/ you (sg. masc.) melt'

In (27), the imperfect 3rd person singular feminine /2nd person singular masculine prefix /ti-/ is attached to the verb roots. The word after syllabification has a high short non-final vowel /i/ in an open syllable, which is the environment of HVD. After vowel deletion, the remaining segment of the prefix /t/ assimilates to the root initial segment. The assimilation is regressive where the prefix /t/ takes on the features of the root initial segment. In other word, the root initial segment takes priority over the prefix, as illustrated in the tableaux in (28).

(28)

i.

/ti-ðu:g/ 'she tastes'	$*i]_\sigma$	AGREE-(Coronal)	IDENT-RtC$_1$
a. [ti.ðu:g]	*!		
b. [tðu:g]		*!	
c. [ttu:g]			*!
☞ d. [ððu:g]			

ii.

/ ti-dʒi:b / 'she brings'			
a. [ti.dʒi:b]	*!		
b. [tdʒi:b]		*!	
c. [tti:b]			*!
☞ d. [dʒdʒi:b]			

In tableaux (28i) and (28ii), candidate (a) is the faithful candidate and it is eliminated because it incurs a fatal violation of $*i]_\sigma$. Candidate (b) incurs also a fatal violation of AGREE-(Coronal) since it does not have identical features of the prefix and root initial segment. Candidates (28c) and (28d) respect $*i]_\sigma$, and AGREE-(Coronal) constraints, however, candidate (28c) does not preserve the initial segment of the root. As a result, Candidate (d) is the optimal candidate since it does not violate any of the constraints.

Not all examples with HVD result in gemination. Gemination is triggered through assimilation only if the root begins with a coronal obstruent, as in (27). The examples in (29) show a number of environments where there is no assimilation between the root initial segment and the prefix after HVD. In (29a), root initial segment is non-coronal. In (29b), the root begins with a sonorant sound. In (29c), although the root begins with a coronal segment, it has the feature [+strident] that blocks assimilation. Finally, examples in (29d) show no assimilation when the first segment of the root is a voiceless [-strident]. These examples are discussed further in what follows.

(29) a. non-coronal root initial segments

/ti-barridd/	[tbar.ridd]	'she /you (sg. masc.) cool'
/ti-ba:ʃir/	[tba:ʃir]	'she /you (sg. masc.) serve'
/t-ba:ri/	[tba:.ri]	'she /you (sg. masc.) match'
/ti-kabbir/	[tkab.bir]	'she /you (sg. masc.) praise Allah'
/ti-ħanni/	[tħan.ni]	'she /you (sg. masc.) apply Henna'
/ti-gu:l/	[tgu:l]	'she /you (sg. masc.) say'

b. root initial sonorant segments

/ti-ra:sil/	[tra:.sil]	'she / you (sg. masc.) correspond'
/ti-rakkib/	[trak.kib]	'she /you (sg. masc.) mount'
/ti-lu:m/	[tlu:m]	'she /you (sg. masc.) blame'
/ti-la:ʕib/	[tla:.ʕib]	'she /you (sg. masc.) play with'
/ti-na:di/	[tna:.di]	'she /you (sg. masc.) call'
/ti-na:giz/	[tna:.giz]	'she /you (sg. masc.) jump around'
/ti-makkinn/	[tmak.kinn]	'she /you (sg. masc.) enable'
/ti-massi/	[tmas.si]	'she /you (sg. masc.) say good evening'

c. [+strident] root initial segments

/ti-su:m/	[tsu:m]	'she /you (sg. masc.) estimate'
/ti-su:g/	[tsu:g]	'she /you (sg. masc.) drive'
/ti-zu:r/	[tzu:r]	'she /you (sg. masc.) visit'
/ti-zugg/	[tzugg]	'she /you (sg. masc.) defecate'
/ti-ʃu:f/	[tʃu:f]	'she /you (sg. masc.) see'
/ti-ʃi:l/	[tʃi:l]	'she /you (sg. masc.) carry'

d. root initial voiceless [-strident] segments

/ti-θu:r/	[tθu:r]	'she /you (sg. masc.) revolt'
/ti-θanni/	[tθan.ni]	'she /you (sg. masc.) bend things'
/ti-θabbit/	[tθab.bit]	'she /you (sg. masc.) stable things'
/ti-θalliθ/	[tθal.liθ]	'she /you (sg. masc.) triple'

In (29a) no assimilation is found when the root of the verb begins with a non-coronal segment. Instead, the segments surface unchanged and a consonant cluster is formed word initially after HVD. The lack of assimilation here suggests that the faithfulness constraints that map between the input and the output are ranked higher than the markedness constraints. Applying the same constraints presented to so far, i.e. AGREE-(Coronal) and IDENT-IO constraints, will not result in the correct output, as shown in the tableau in (30).

(30)

/ti-barrid/'she cools'	$*i]_\sigma$	AGREE-(Coronal)	IDENT-IO (F)	IDENT-RtC$_1$
a. [ti.bar.rid]	*!			
☹ b. [tbar.rid]		*!		
c. [ttar.rid]			*	*!
*d. [bbar.rid]			*	

In tableau (22), the constraint AGREE-(Coronal), which favors assimilation, outranks the faithfulness constraint IDENT-IO (F), which preserves the input features. Implementing the same order of constraints does not yield the correct output for the examples in (29a). As in the tableau in (30), candidate (a) is eliminated by the highest constraint $*i]_\sigma$ since it has a high vowel in an open syllable word medially. Candidate (b), which should be the optimal candidate, is eliminated by AGREE-(Coronal) because it does not assimilate adjacent coronals. Candidates (c) and (d) are equal in almost all constraints but differ in the direction of assimilation. The tie is resolved by the final constraint IDENT-RtC_1, which preserves the initial segment of the root in the output. The wrongfully winning candidate in (d) has the same first segment of the root in the input and the output, unlike candidate (c).

Deranking the constraint AGREE-(Coronal) and promoting the constraint IDENT-IO (F) in the ranking argument in tableau (30) would resolve the issue, but it will cause a problem in tableaux (22) and (23) for the definite article /ʔal-/.

The other possibility is to promote the constraint IDENT-RtC_1 above the assimilation constraint AGREE-(Coronal), as in tableau (31). While this step eliminates candidate (30c), it will not offer any solution for candidate (d), which will remain the wrongfully selected winner.

(31)

/ti-barrid/ ‘she cools’	*i]$_\sigma$	IDENT-RtC_1	AGREE-(Coronal)	IDENT-IO (F)
a. [ti.bar.rid]	*!			
☹ b. [tbar.rid]			*!	
c. [ttar.rid]		*!		
*d. [bbar.rid]				*

The difference between the expected winner in candidate (31b) and the unwanted winner in candidate (31d) is that candidate (31b) preserves the prefix, while (31d) assimilates the root initial segment to the prefix. Candidate (31b) can become the winner if the prefix is preserved through a constraint that militates against complete assimilation of the prefix. This is possible through the constraint Exponence (e.g. Golston 1995; Xu 2007), given in (32).

(32) Exponence (Golston 1995)
Morphemes should be overt on the surface

The constraint in (32) is a faithfulness constraint that requires morphemes to be explicitly realized in the output. The degree of application of this constraint is interpreted differently in different works, we assume here that total assimilation of the affix to the root to the extent that no part of the affix is overtly realized in the output incurs a violation of the Exponence constraint. Testing the order between the Exponence constraint and the other constraints generates the expected output, as in the tableau in (33).

(33)

/ti-barrid/ ‘she cools’	*i]σ	Exponence	IDENT-RtC_1	AGREE-(Coronal)	IDENT-IO (F)
a. [ti.bar.rid]	*!				
☞ b. [tbar.rid]				*	
c. [ttar.rid]			*!		*
d. [bbar.rid]		*!			*

Candidate (33b) is the optimal candidate because it overtly realizes the prefix in the output, whereas candidate (33d) is eliminated through the Exponence constraint because it assimilates the prefix to the root. While candidate (33c) satisfies the Exponence constraint, it fatally violates the IDENT-RtC$_1$ constraint since it does not preserve the initial segment of the root.

However, testing the constraints in (33) with the examples in (27), repeated in (34), where the prefix assimilates to the root initial segment, leads to an incorrect outcome. Unlike the example in tableau (33), the clusters in (34) after HVD are expected to undergo assimilation resulting in word initial geminates.

(34)	/ti-dabbir/	[ddab.bir]	'she/ you (sg. masc.) deal with'
	/ti-darrik/	[ddar.rik]	'she/ you (sg. masc.) grab tightly'
	/ti-dʒi:b/	[dʒdʒi:b]	'she/ you (sg. masc.) bring'
	/ti-dʒammiʕ/	[dʒdʒam.miʕ]	'she/ you (sg. masc.) gather'
	/ti-da:fiʕ/	[dda:.fiʕ]	'she/ you (sg. masc.) defend'
	/ti-dahhin/	[ddah.hin]	'she/ you (sg. masc.) smear'

In /ti-barrid/ 'she cools', in tableau (33), the output shows no assimilation and the input features of the prefix and the root initial segment are preserved, i.e. [tba.rrid]. However, in (34) the output shows a total assimilation between the prefix and the first segment of the root. The resulting adjacent segments after HVD in (34) are coronal segments, unlike in (29a), as illustrated in (33), where the root initial segment is non-coronal. Applying the same constraints in tableau (33) for the examples in (34), therefore, does not yield the correct output, as in the tableaux in (35). The constraints in (35) favor the output that preserves the input features and disfavors assimilation.

(35)

/ti-dabbir/'she deals with'	*i]σ	Exponence	IDENT-RtC$_1$	AGREE-(Coronal)	IDENT-IO (F)
a. [ti.dab.bir]	*!				
*b. [tda.bir]				*	
c. [ttab.bir]			*!		*
☹ d. [ddab.bir]		*!			*

/ti-ðu:g/ 'she tastes'					
a. [ti.ðu:g]	*!				
*b. [tðu:g]				*	
c. [ttu:g]			*!		*
☹ d. [ððu:g]		*!			*

Closely examining the examples in (34), after HVD and before assimilation, the resulting sequence is [td] which has the features [-sonorant] and [-continuant]. This sequence is banned in BSD, similar to other Arabic dialects (e.g. Alahmari 2018; Alhuwaykim 2018, Al Solami 2020). One principle that deals with phonotactic restrictions in Arabic is the Obligatory Contour Principle, OCP, (McCarthy, 1986; Yip, 1988), which is given in (36).

(36) Obligatory Contour Principle (OCP)
At the melodic level, adjacent identical elements are prohibited.

In BSD, a tautosyllabic [-continuant] obstruent coronal is disallowed, as in the constraint in (37).

(37) OCP-Cor[-sonorant][-continuant] (Alahmari, 2018; Morelli, 1999)
OCP-Cor[-son.][-cont.]
Tautosyllabic [-continuant] coronal obstruents are disallowed.

Consonants within a root that share the same place features are disfavored by the OCP. The constraint in (37) incurs a violation to clusters such as *[td], and *[tdʒ]. In addition to vowel epenthesis and blocking HVD found in some Arabic dialects, gemination is a common phonological process that prevents these clusters from surfacing, as in the tableau in (38).

(38)

/ti-dabbir/	*i]σ	OCP-Cor[-son.][-cont.]	IDENT-RtC$_1$	Exponence	AGREE-(Coronal)	IDENT-IO (F)
a. [ti.dab.bir]	*!					
b. [tdab.bir]		*!			*	
☞c. [ddab.bir]				*		*
d. [ttab.bir]			*!			*

Continuing with the examples in (29), a consonant cluster in the onset that contains a sonorant sound, as in (29b), repeated in (39), does not trigger gemination. The output in (39) is faithful to the input and does not show assimilation, as in the tableaux in (40).

(39)

/ti-ra:sil/	[tra:.sil]	'she /you (sg. masc.) correspond'
/ti-rakkib/	[trak.kib]	'she /you (sg. masc.) mount'
/ti-lu:m/	[tlu:m]	'she /you (sg. masc.) blame'
/ti-la:ʕib/	[tla:.ʕib]	'she /you (sg. masc.) play with'
/ti-na:di/	[tna:.di]	'she /you (sg. masc.) call'
/ti-na:giz/	[tna:.giz]	'she /you (sg. masc.) jump around'
/ti-makkinn/	[tmak.kinn]	'she /you (sg. masc.) enable'
/ti-massi/	[tmas.si]	'she /you (sg. masc.) say good evening'

(40)
i.

/ti-rakkib/ 'she mounts'	*i]σ	OCP-Cor[-son.][-cont.]	IDENT-RtC$_1$	Exponence	AGREE-(Coronal)
a. [ti.rak.kib]	*!				
☞b. [trak.kib]					*
c. [rrak.kib]				*!	
d. [ttak.kib]			*!		

ii.

/ni-zu:r/ 'we visit'					
a. [ni.zu:r]	*!				
☞ b. [nzu:r]					*
c. [zzu:r]				*!	
d. [nnu:r]			*!		

In tableaux (40i) and (40ii), the constraint OCP-Cor[-son.][-cont.] is not active. Candidate (b) in each tableau is the optimal candidate since it does not incur any violation of the dominating constraints. Candidate (a) is eliminated because of the high short vowel [i] in an open syllable. Assimilation is penalized in candidates (c) and (d) in each tableau because of the faithfulness constraints Exponence and IDENT-C_1, respectively.

The tableau in (38) shows that the IDENT-RtC_1 constraint outranks the Exponence constraint, while the tableaux in (40) show that the Exponence constraint outranks the AGREE-(Coronal) constraint. The order of the constraints discussed so far is given in (41).

(41) *i]σ, OCP-Cor[-son][-cont], IDENT-RtC_1 >> Exponence >> AGREE- (Coronal), IDENT-IO(F)

The remaining examples in (29), repeated in (42), show that a [+strident] root initially does not trigger assimilation, as in (42a). In (42b), similarly, no assimilation occurs when the root begins with a voiceless [-strident] sound, compare this with (42c) where the prefix assimilates to the root initial segment if it is a voiced [-strident] sound.

(42) a. root initial [+strident] segments

/ti-su:m/	[tsu:m]	'she estimates'
/ti-zu:r/	[tzu:r]	'she visits'
/ti-ʃi:l/	[tʃi:l]	'she carries'

b. root initial voiceless [-strident] segments

/ti-θu:r/	[tθu:r]	'she /you (sg. masc.) revolt'
/ti-θanni/	[tθan.ni]	'she /you (sg. masc.) bend things'
/ti-θabbit/	[tθab.bit]	'she /you (sg. masc.) stable things'
/ti-θalliθ/	[tθal.liθ]	'she /you (sg. masc.) triple'

c. root initial voiced [-strident] segments

/ti-ðu:g/	[ððu:g]	'she tastes'
/ti-ðu:b/	[ððu:b]	'she melts'
/ti-ðu:d/	[ððu:d]	'she defends'

The constraints we discussed so far can account for the examples in (42a), as in (43) where the outcome is not different from the tableaux in (40). The constraint OCP-Cor[-son.][-cont.] is not active in this tableau since its conditions are not met.

(43)

/ti-su:m/ 'she estimates'	*i]σ	OCP-Cor[-son.][-cont.]	IDENT-RtC_1	Exponence	AGREE-(Coronal)	IDENT-IO (F)
a. [ti.su:m]	*!					
☞ b. [tsu:m]					*	
c. [ssu:m]				*!		*
d. [ttu:m]			*!			*

However, the OCP constraint in (37) cannot account for the examples in (42b) and (42c). Each set has a [-strident] segment root initially. They differ only in voicing, where (b) is voiceless, (c) is voiced. A constraint that can capture this difference is given in (44).

(44) OCP-Cor[-son.][-strident, +voice]
A sequence of tautosyllabic coronal obstruent and a voiced [-strident] is disallowed.

The constraint in (44) prohibits any cluster that has a combination of a coronal obstruent and a voiced [-strident] coronal, as in the tableau in (45i). It allows a combination of a coronal obstruent and a voiceless [-strident] coronal in the output, as in the tableau in (45ii).

(45)

i.

/ti-ðu:g/ ‘she tastes’	*i]σ	OCP-Cor[-son.][-strident, +voice]	IDENT-RtC_1	Exponence	AGREE-(Coronal)	IDENT-IO (F)
a. [ti.ðu:g]	*!					
b. [tðu:g]		*!			*	
☞ c. [ððu:g]				*		*
d. [ttu:g]			*!			*

ii.

/ti-θu:r/ ‘she revolts’						
a. [ti.θu:r]	*!					
☞ b. [tθu:r]					*	
c. [θθu:r]				*!		*
d. [ttu:r]			*!			*

In tableau (45i) Candidates (b), (c), and (d) differ in assimilation. In (45ib) no assimilation takes place. This incurs a fatal violation of the OCP constraint that militates against the consonant cluster *[tð] because it has a coronal obstruent followed by a voiced [-strident] coronal. Candidates (45ic) and (45id) avoid this cluster through gemination. However, the optimal candidate in (45ic) preserves the features of the root, while candidate (45id) assimilates the root initial segment to the prefix, which incurs a fatal violation of the constraint IDENT-RtC_1. In this example, the direction of assimilation is essential in selecting the winning candidate.

In tableau (45ii), the optimal candidate is (45iib), which does not change any of the features of the input and only deletes the high vowel. Candidates (45iic) and (45iid) undergo assimilation and are ruled out by the faithfulness constraints Exponence and IDENT-RtC_1, respectively.

Retesting the constraints in tableaux (45) with the tableaux in (22) and (23), for the definite article /ʔal-/, shows the correct output, as in the tableaux in (46).

(46)

i.

/ʔal-sard/ ‘narration’	IDENT-RtC_1	Exponence	AGREE-(Coronal)	IDENT-IO (F)
a. [ʔal.sard]			*!	
☞ b. [ʔas.sard]				*
c. [ʔal.lard]	*!			

ii.

/ʔal-kalb/ ‘the dog’				
a. [ʔak.kalb]				*!
☞ b. [ʔal.kalb]				
c. [ʔal.lalb]	*!			

In both tableaux in (46), the Exponence constraint is not violated. The input features of the prefix remain overtly realized in the output since it avoids total assimilation. This is different from the tableau in (45), for example, where candidate (c) assimilates the prefix to the following segment to the extent that it is no longer available in the output. Candidate (46ib) is the optimal candidate because it does not violate the faithfulness constraint IDENT-RtC$_1$ and preserves the root initial segment and, in addition, it respects the AGREE-(Coronal) that requires assimilation between adjacent coronal segments. In tableau (46ii), candidate (b) is the optimal candidate since it does not violate the faithfulness constraints IDENT-RtC$_1$ and IDENT-IO (F). The tableau in (46i) shows that the constraint AGREE-(Coronal) outranks the IDENT-IO (F) constraint.

A further gemination outcome due to assimilation is found when a final segment of a verb assimilates to a following 1st person/2nd person singular masculine suffix /-t/. The output is the mirror image of consonant clusters in word initial position due to HVD in (29). The assimilation always occurs when the verb ends with a [-continuant] coronal obstruent, as in (47a), or a voiced [-strident] coronal obstruent, as in (47b). The assimilation, which results in geminates, in these examples is a process through which the clusters *[dt] and *[ðt] are avoided. This is similar to the process discussed in examples (38) and (42c).

(47) a. verb roots ending in [-continuant] coronal obstruent

/ʕabad-t/	[ʕa.batt]	'I/ you (sg. masc.) worshipped'
/ħarad-t/	[ħa.ratt]	'I/ you (sg. masc.) threw'
/nabat-t/	[na.batt]	'I/ you (sg. masc.) was rooted'
/sakat-t/	[sa.katt]	'I/ you (sg. masc.) kept silence'

b. verb roots ending in a voiced [-strident] coronal obstruent

/ʔaχað-t/	[ʔa.χatt]	'I/ you (sg. masc.) took'
/ʔangað-t/	[ʔan.gatt]	'I/ you (sg. masc.) rescued'
/ʃaʕwað-t/	[ʃaʕ.watt]	'I/ you (sg. masc.) practiced witchcraft'

The assimilation process in (47) is similar to the assimilation process discussed in (22), and (27) in the definite article and the assimilation due to HVD in word initial position, where the feature of one segment takes over the other segment. However, in (22) and (27) the root featural identity is preserved, while in (47) the featural identity of the suffix is preserved. What both assimilation processes have in common is that the assimilation is regressive and that in all these instances of assimilation a coronal consonant occurring before another coronal must be identical with it. The constraints discussed so far lead to the desirable output, as illustrated in the tableaux in (48).

(48)
i.

/ʕabad-t/ 'I/ you (sg. masc.) worshipped'	OCP-Cor[-son.][-cont.]	OCP-Cor[-son][-strident, +voice]	IDENT-RtC$_1$	Exponence	AGREE-Coronal)	IDENT-IO (F)
a. [ʕa.badt]	*!				*	
☞ b.[ʕa.batt]						*
c. [ʕa.badd]				*!		*

ii.

/ʔaχað-t/ ‘I/ you (sg. masc.) took’						
a. [ʔa.χaðt]		*!			*	
☞b.[ʔa.χatt]						*
c. [ʔa.χaðð]				*!		*

The tableaux in (48) show how the banned consonant clusters are prevented through the high ranking of the OCP constraints. In (48ia), the consonant cluster *[dt] is prohibited and violates the constraint OCP-Cor[-son.][-cont.]. Similarly, candidate (48iia) is eliminated because it violates the constraint OCP-Cor[-son.][-strident, +voice] that prohibits the cluster *[ðt]. The difference between the optimal candidate in (b), in both tableaux, and the eliminated candidate in (c) is in the direction of assimilation. The optimal candidate has a regressive assimilation where the features of the suffix are preserved, while the eliminated candidate in (c) has a progressive assimilation where the features of the root final segment are prioritized. The direction of assimilation here is similar to the one discussed above in (22) and (38), where assimilation is regressive.

The regressive direction of assimilation discussed so far suggests that the root initial position in BSD is immune to change, unlike the root final position. As a result, in unwanted consonant clusters in the onset, the features of the root initial segment are preserved, while in unwanted consonant clusters in the coda position, the root final segment is prone to change.

Assimilation direction results in different types of geminates in word initial and word final positions. In tableaux (38) and (45i) the prohibited clusters *[td] and *[tð] in word initial position surface as [dd] and [ðð], respectively, because of the regressive assimilation. The mirror image of these consonant clusters in word final position are *[dt] in tableau (48i) and *[ðt] in tableau (48ii), and the outcome after assimilation is [tt] since the features of the suffix /-t/ are prioritized in this position.

Similar to the discussion above in (29), no assimilation takes place when the verb ends with either a non-coronal, as in (49a), a sonorant, as in (49b), a [+strident] coronal, as in (49c), or a voiceless [-strident] coronal, as in (49d).

(49) a. verb roots ending with a non-coronal [-sonorant]

/taʕib-t/	[ta.ʕibt]	‘I/ you (sg. masc.) got tired’
/samiʕ-t/	[sa.miʕt]	‘I/ you (sg. masc.) heard’
/masak-t/	[ma.sakt]	‘I/ you (sg. masc.) grabbed’
/fa:rag-t/	[fa:.ragt]	‘I/ you (sg. masc.) got separated’

b. verb roots ending with a sonorant

/sa:far-t/	[sa:.fart]	‘I/ you (sg. masc.) travelled’
/nazal-t/	[na.zalt]	‘I/ you (sg. masc.) came down’
/samin-t/	[sa.mint]	I/ you (sg. masc.) got obese’
/salim-t/	[sa.limt]	‘I/ you (sg. masc.) were saved’

c. verb roots ending with a voiced [+strident] coronal

/labis-t/	[la.bist]	‘I/ you (sg. masc.) wore’
/χamaʃ-t/	[χa.maʃt]	‘I/ you (sg. masc.) scratched’
/rakkaz-t/	[rak.kazt]	‘I/ you (sg. masc.) concentrated’

d. verbs ending a voiceless [-strident] coronal

/waraθ-t/	[wa.raθt]	‘I/ you (sg. masc.) inherited’
/ʕabaθ-t/	[ʕa.baθt]	‘I/ you (sg. masc.) tampered with’

The different outcomes in (49) are illustrated in the tableaux in (50). As the tableaux show, while the constraints discussed so far can account for (49a), they do not give the correct output for (49b), (49c), and (49d).

(50)
i.

i. /taʕib-t/ 'I/ you (sg. masc.) got tired'	OCP-Cor[-son][-cont]	OCP-Cor[-son][+voice, -strident]	IDENT-RtC$_1$	Exponence	AGREE-(Coronal)	IDENT-IO (F)
☞a. [ta.ʕibt]						
b. [ta.ʕibb]				*!		*
c. [ta.ʕitt]						*!

ii.

ii. / ʁa:mar-t/ 'I/ you (sg. masc.) gambled'						
☹ a. [ʁa:mart]					*!	
b. [ʁa:marr]				*!		*
*c. [ʁa:matt]						*

iii.

/labis-t/ 'I/ you (sg. masc.) wore'						
☹ a. [la.bist]					*!	
b. [la.biss]				*!		*
*c. [la.bitt]						*

iv.

/waraθ-t/ 'I/ you (sg. masc.) inherited'						
☹ a. [wa.raθt]					*!	
b. [wa.raθθ]				*!		*
*c. [wa.ratt]						*

In tableaux (50), candidates (iic), (iiic), and (ivc) are wrongfully selected as winners. The expected output in (iia), (iiia), and (iva) violate the assimilation constraint AGREE-(Coronal). The assimilation process is in not expected in these candidates since the word final cluster in (ii) has a sonorant, similar to word initial cluster in (40), a [+strident] in (iii) similar to (43), and in (iv) it has a voiceless [-strident], similar to (45ii).

The assimilation processes discussed in word initial and word final positions in BSD, in the form of gemination, are implemented as a strategy to avoid violating the OCP constraints, otherwise the featural identity of the input is favored through the faithfulness constraints. In other words, BSD ranks the faithfulness constraints that preserve the input after the OCP constraints.

In the discussion so far, after the high ranking of the OCP constraints, preserving the features of root initial segments is made possible through ranking the constraint IDENT-Rt-C$_1$, which prohibits any changes to root initial position, higher than the Exponence constraint, which preserves the affix. This ranking argument avoids progressive assimilation where the prefix features are preserved while the features of the root initial segment are assimilated.

Similarly, unwanted word final clusters are avoided through gemination, which is enforced by ranking the OCP constraints higher than the faithfulness constraints. What is needed to account for the examples in (50iia), (iiia), and (iva) is a constraint that can maintain the featural identity of the root final segment in words where assimilation is not enforced by the OCP constraints. This is possible through implementing the constraint IDENT-RtC_{last}, in (51).

(51) IDENT-RtC_{last} (C_{last} refers to the last consonant of the root) An input feature specification in the last segment of the root and its output correspondent must be identical.

Ranking the constraint in (51) after the Exponence constraint eliminates any progressive assimilation and gives the correct output, as in the tableaux in (52).

(52)

i.

/taʕib-t/ 'I/ you (sg. Masc.) got tired'	OCP-Cor[-son.][-cont.]	OCP-Cor[-son.][-strident, +voice]	IDENT-Rt-C_1	Exponence	IDENT-Rt-C_{last}	AGREE-(Coronal)
☞a. [ta.ʕibt]						
b. [ta.ʕibb]				*!		
c. [ta.ʕitt]					*!	

ii.

/ʁa:mar-t/ 'I/ you (sg. Masc.) gambled'						
☞a.[ʁa:.mart]						*
b. [ʁa:.marr]				*!		
c. [ʁa:.matt]					*!	

iii.

/labis-t/ 'I/ you (sg. Masc.) wore'						
☞a. [la.bist]						*
b. [la.biss]				*!		
c. [la.bitt]					*!	

iv.

/ waraθ-t/ 'I/ you (sg. masc.) inherited'						
☞a. [wa.raθt]						*
b. [wa.raθθ]				*!		
c. [wa.ratt]					*!	

Since no disfavored consonant clusters are found in the tableaux in (52), the optimal candidates are the ones that preserve word final clusters of the input and avoid gemination, i.e. (ia), (iia), (iiia), and (iva). The constraint IDENT-RtC_{last} eliminates any candidate that alters the final segment of the root through regressive assimilation. Combined with the Exponence constraint, which prohibits progressive assimilation and totally assimilating the suffix in these examples, the two constraints conspire to preserve the word final consonant clusters. The tableaux in (52ii-iv) show that the constraint IDENT-RtC$_{last}$ outranks the AGREE-(Coronal) constraint. This concludes the discussion of the examples in (49).

A nasal plus consonant sequence is considered a marked phonological structure (Hyman 2003), referred to in the literature as *NC cluster. Most languages avoid this sequence through a number of repair strategies including assimilation, deletion, or vowel epenthesis (Pater 1999; De Lacy 2007).

In BSD, nasal place assimilation occurs in a structure where an alveolar nasal /n/ assimilates the place features of a following sonorant consonant, as in (53a), but not to a following obstruent, as in (53b). Nasal /n/ does not assimilate to a following glide, as in (53c). In addition, the bilabial nasal /m/ in BSD does not assimilate to a following consonant, as in (53d).

(53) a. nasal /n/ plus sonorant consonant

/ni-ra:sil/	[rra.:sil]	‘we correspond’
/ni-rakkib/	[rrak.kib]	‘we mount’
/ni-lu:m/	[llu:m]	‘we blame’
/ni-la:ʕib/	[lla:.ʕib]	‘we play with’
/ni-na:di/	[nna:.di]	‘we call’
/ni-na:giz/	[nna:.giz]	‘we jump around’
/ni-makkinn/	[mmak.kinn]	‘we enable’
/ni-massi/	[mmas.si]	‘we say good evening’

b. nasal /n/ plus obstruent consonant

/ni-takki/	[ntak.ki]	‘we recline’
/ni-daffi/	[ndaf.fi]	‘we warm’
/ni-fakkir/	[nfak.kir]	‘we think’
/ni-sa:fir/	[nsa:.fir]	‘we travel’
/ni-ʕabbi/	[nʕab.bi]	‘we fill’

c. nasal /n/ plus a glide

/ni-wazziʕ/	[nwaz.ziʕ]	‘we distribute’
/ni-waggi/	[nwag.gi]	‘we cover from fire’
/ni-walliʕ/	[nwal.liʕ]	‘we light’
/ni-waffi/	[nwaf.fi]	‘we add more’
/ni-wassiʕ/	[nwas.siʕ]	‘we widen’
/ni-jassir/	[njas.sir]	‘we facilitate’
/ni-jabbis/	[njab.bis]	‘we harden’
/ni-jattim/	[njat.tim]	‘we orphan’
/ni-jammin/	[njam.min]	‘we go right’

d. bilabial nasal /m/ plus a consonant

/mi-rabba/	[mrab.ba]	‘jam’
/mi-rabbi/	[mrab.bi]	‘he is growing something’
/mi-nazzil/	[mnaz.zil]	‘he lowers something’
/mi-kassir/	[mkas.sir]	‘he smashes something’

Based on the data in (53), we can write the markedness constraint in (54).

(54) *OCP[nasal, coronal][+consonantal, +sonorant]
(*OCP[nas., coro.][+cons., +son.]
No coronal nasal plus sonorant consonant sequence.

Because the bilabial nasal /m/ patterns in a different way from the alveolar nasal, the constraint in (54) has the value feature [coronal]. The value feature [+consonantal] in (54) is needed to exclude glides, which are [-consonantal].

According to the examples in (53), any prohibited combination is avoided through total assimilation. Note that the assimilation process is regressive where the root initial segment is preserved in the output, similar to the assimilation discussed so far. Implementing the constraint in (54) yields the correct output, as in the tableaux in (55).

(55)
i.

/ni-ra:sil/ 'we correspond'	*i]σ	OCP-Cor[-son][-cont]	OCP-Cor[-son][-strident, +voice]	*OCP[nas., coro.][+cons., +son.]	IDENT-Rt-C_1
a. [ni.ra:.sil]	*!				
b. [nra:.sil]				*!	
☞ c. [rra:.sil]					
d. [nna:.sil]					*!

ii.

/ni-makkin/ 'we enable'					
a. [ni.mak.kin]	*!				
b. [nmak.kin]				*!	
☞ c. [mmak.kin]					
d. [nnak.kin]					*!

In the tableaux in (55), candidates (ic) and (iic) are the optimal candidates because they undergo assimilation regressively and the root initial consonant is preserved at the expense of the prefix, after HVD. They avoid violating the OCP constraint that prohibits a sequence of a coronal nasal and a sonorant, in addition, they do not violate the faithfulness constraint IDENT-Rt-C_1 that preserves root initial segment.

The markedness constraint in (54) is ranked higher than the faithfulness constraints. This order ensures that assimilation in BSD, which results in word initial geminates in this case, is only triggered to avoid unwanted consonant clusters. Otherwise, the consonant cluster surfaces unchanged. The order of the constraints discussed so far is given in (56).

(56) *i]σ, OCP constraints, IDENT-RtC_1 >> Exponence, IDENT-Rt-C_{last} >> AGREE-(Coronal) >> IDENT-IO (F)

Another process that triggers geminations in BSD is to satisfy weight requirement in the dialect. This is discussed in the next section.

4.2.2. Gemination due to weight requirement

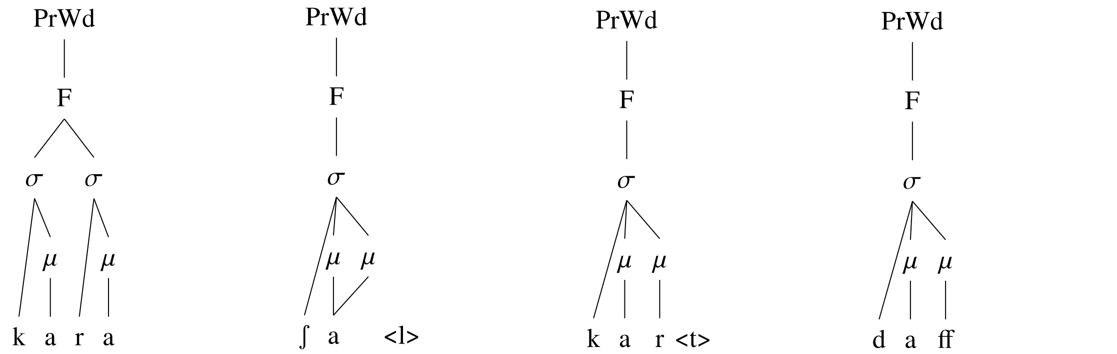
Before discussing the gemination due to weight parameters in the dialect, the moraic weight requirement of words in BSD needs to be explored. As the case with a lot of Arabic dialects, BSD requires words to have at least two moras to receive stress. Within the prosodic hierarchy (Selkirk 1980; McCarthy and Prince 1986), every word requires a binary foot with two moras (Hayes 1995, 47; McCarthy and Prince 1990, 17; Kager 2007, 223). The two-mora requirement in words can be obtained in BSD by at least two open syllables with short vowels, CVCV, a closed syllable with a long vowel CV:C, or a closed syllable with a coda cluster CVCC or a closed syllable with a geminate CVG, as in (57).

(57) Minimum word shapes in BSD

CVCV	CV:C	CVCC	CVG
[ka.ra] 'laboured'	[ʃa:l] 'he carried'	[gilt] 'I said'	[daff] 'pushed'
[da.fa] 'warmth'	[da:r] 'house'	[sabt] 'Saturday'	[ruzz] 'rice'
[la.ga] 'he found'	[na:r] 'fire'	[kart] 'card'	[madd] 'extended'

Final consonant extrametricality (Liberman and Prince 1977; Nanni 1977; Hayes 1979, 1982, 1995) is an active parameter in BSD, see Al Solami (forthcoming) for more discussion of extrametricality in BSD. Final consonant extrametricality does not allow a final consonant in a syllable to be counted toward the moraic weight of that syllable, as in (58b) and (58c), which is different from a geminate, in (58d), which cannot be extrametrical due to its inherent moraic weight, as discussed further below.

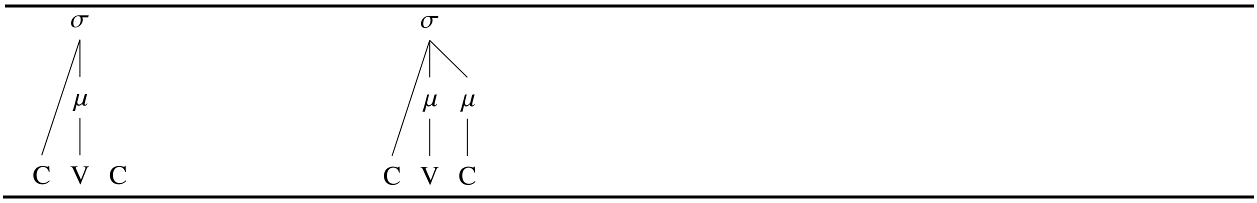
(58) a. b. c. d.



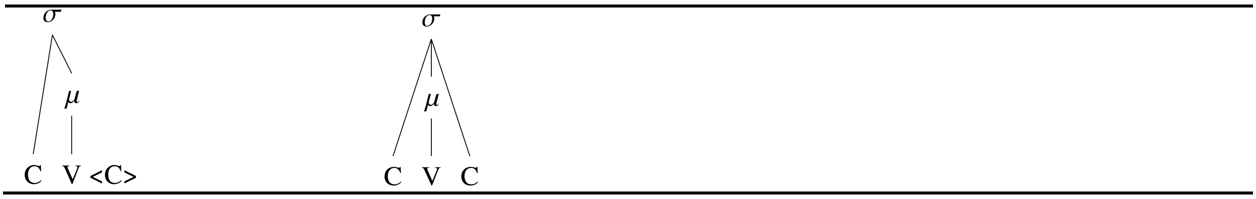
The words in the representations in (58) are bimoraic. The representations in (58) indicate the absence of words with only CV or CVC syllable shapes in BSD. CV syllable is monomoraic since it has a single moraic unit, the vowel, whereas CVC syllable in BSD, and in many other Arabic dialects, has a mora attached to its short vowel and is assigned a mora to the coda position through weight by position, WBP (Hayes 1989b, 258, 1995, 52). When CVC syllable is in final position, its coda is non-moraic due to extrametricality, as in (59b).

(59) CVC weight in BSD and WBP

a.



b.



The asymmetrical pattern of CVC syllable in BSD in (59) is evident in the absence of stress on CVC word-finally, compared to a non-final CVC syllable, as in the examples in (60).

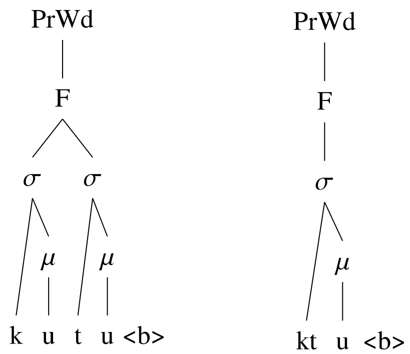
(60) a. [ʔa.ká.lat] ‘she ate’
b. [ʔa.ka.lát.ha] ‘she ate it (fem.)’

Altering the moraic weight of words in BSD through vowel deletion results in gemination. Gemination is a way of satisfying the moraic weight requirements of words in BSD. In the examples in (61), before the application of HVD, each word has two moras. The application of HVD renders the words monomoraic, which is not allowed in BSD.

(61)

		HVD
/kutub/ ‘books’	ku$_{\mu}$.tu$_{\mu}$<b>	ktu$_{\mu}$<b>
/furuʃ/ ‘rugs’	fu$_{\mu}$.ru$_{\mu}$<ʃ>	fru$_{\mu}$<ʃ>
/luħuf// ‘blankets’	lu$_{\mu}$.ħu$_{\mu}$<f>	lħu$_{\mu}$<f>
/birak/ ‘ponds’	bi$_{\mu}$.ra$_{\mu}$<k>	bra$_{\mu}$<k>

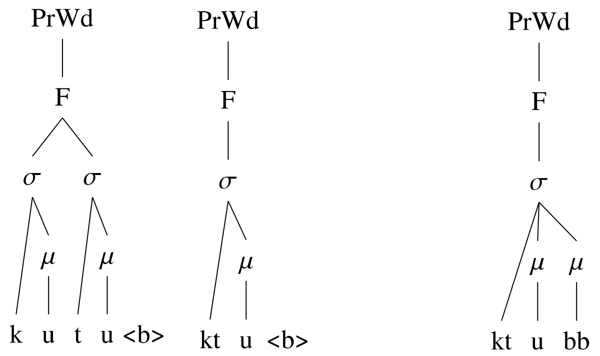
ku.tu<b> ktu<b>



The deletion of a mora in (61) triggers gemination, as in (62c). Gemination in this instance is a form of compensatory lengthening. Compensatory lengthening is attested in many languages and is implemented to satisfy the minimal moraic requirements in different languages. Compensatory lengthening is a repair mechanism that restores the moraic weight of the word when a mora is lost due to deletion or extrametricality (Hayes 1989a; Harris 2011; Kavitskaya 2014). For BSD, since a final singleton consonant is extrametrical and cannot be a weight-bearing unit, the consonant is geminated to avoid extrametricality.

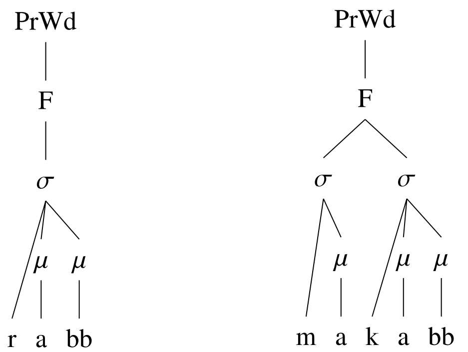
(62)

a.	b. HVD		c. Gemination
/kutub/ ‘books’	ku$_{\mu}$.tu$_{\mu}$<b>	ktu$_{\mu}$<b>	ktubb
/furuʃ/ ‘rugs’	fu$_{\mu}$.ru$_{\mu}$<ʃ>	fru$_{\mu}$<ʃ>	fruʃʃ
/luħuf// ‘blankets’	lu$_{\mu}$.ħu$_{\mu}$<f>	lħu$_{\mu}$<f>	lħuff
/birak/ ‘ponds’	bi$_{\mu}$.ra$_{\mu}$<k>	bra$_{\mu}$<k>	brakk
/kutub/ ‘books’	ku.tub	ktub	[ktubb]



In (62c), after HVD, the final consonant is geminated and assigned a mora. This process ensures the avoidance of extrametricality, which is similar to words with underlying geminates, as in (63), where the weight is inherent.

(63) [rabb] ‘god’ [ma.kabb] ‘dumpster’



In addition to the previously introduced constraints, in dealing with the examples of gemination in (62c), the following constraint in (64) is used. The constraint MinWrd incurs a violation in any subminimal word with less than two moras. It ensures that words are within the needed moraic weight limit in BSD, as in the tableau in (65).

(64) Word Minimality (MinWrd)
Words are minimally bimoraic

(65)

/kutub/ ‘books’	*i]$_{\sigma}$	MinWrd	*GEM
a. [ku.tub]	*!		
b. [ktub]		*!	
☞c. [ktubb]			*

Candidate (65a) fatally violates the constraint *i]$_{\sigma}$ by allowing the high short vowel in an open syllable to surface. Candidate (65b) does not compensate for the lost mora due to HVD, which violates the MinWrd constraint. Candidate (65c) is the optimal candidate. It lengthens, geminates, the final consonant and satisfies the minimal word requirement.

5. Conclusion

In conclusion, this paper provided a phonological description of geminates in BSD within the framework of Optimality Theory. It examined possible positions of geminates in BSD and showed that geminates in BSD can occur word initially, due to assimilation, word medially, or word finally. Geminates can be lexical or phonologically derived in BSD. Lexical geminates contrast with singleton consonants underlyingly. Phonologically derived geminates, on the other hand, result from assimilation between the root and affixes.

The ranking arguments between different constraints showed that in BSD the markedness constraints that prohibit certain consonant clusters in the output are ranked higher than the faithfulness constraints. Consequently, in words where consonant clusters are not prohibited, such consonant clusters surface without change. This suggests that gemination in BSD is a mechanism that eliminates phonologically marked structures.

Another possible source of gemination in BSD is to satisfy minimal weight requirement after vowel deletion. Vowel deletion changes the weight of words through deleting a mora associated with a vowel. To maintain the needed moraic weight of words, consonant lengthening takes place, through gemination, to compensate for the lost mora.

This paper did not discuss morphologically derived geminates, which are possible in BSD. This is a topic that needs to be explored in a future paper. In addition, geminates can be explored from a phonetic perspective. It would be interesting to compare phonologically triggered geminates with lexical geminates in BSD in terms of timing properties, duration, and other acoustic cues to see if they are different.

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