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Geminate latency in Djibouti Somali: a pilot study

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Our aim in this article is first to contribute to the documentation of the diatopic variation in the realization of Somali geminates, and second to determine whether Djibouti Somali exhibits geminate latency, on a par with Standard Somali (Barillot 2002, Barillot & Ségéral 2005). To this effect, we present the results of two production experiments that were conducted with one Djibouti Somali speaker. Section 1 examines the realization of the contrast /b, d, g/ vs /bb, dd, gg/ in nouns in Djibouti Somali (Experiment 1-NOUNS) in comparison with the previous experiment we conducted on Standard Somali (Bendjaballah & Le Gac 2021). Based on the results of this experiment, Section 2 addresses the question of geminate latency in Djibouti Somali. ‘Latent’ geminates are segments that are phonologically long but whose phonetic duration is short. We examine the acoustic realization of voiced singletons (/b, d, g/), voiced geminates (/bb, dd, gg/) and voiceless geminates (/tt, kk/) in Djibouti Somali (Experiment 2-VERBS). Section 3 concludes the article, and argues in favour of an extension of geminate latency both in Standard Somali and in Djibouti Somali: geminate latency does not only concern the voiceless stops but also the voiced stops.

1 The acoustic realization of the contrast singleton vs geminate /b, d, g/ in Somali nouns

1.1 Standard Somali

Table 1 provides the Somali surface consonant inventory as usually described in the literature.¹ The consonants that appear in the grey cells are those consonants that are assumed to have geminate counterparts at the phonetic level: it is generally assumed that all voiced consonants, except for the pharyngeal fricative, and the glides can be geminated. By contrast, voiceless consonants do not geminate, this includes the uvular and the laryngeal stops. In this article, we concentrate on the acoustics of the stop series /b, t, d, k, g/.

¹ Where Somali orthography diverges from IPA, we give the transcription in Somali orthography in parentheses. Note that the list of the consonants that have geminate counterparts itself is a matter of debate in the literature. In addition to the consonants that are marked as such in Table 1, Armstrong (1934: 123, 139) provides examples with geminated [q] and [w], and Bell (1953: §53) has examples with geminated [y]. In these examples however the reported gemination seems to be conditioned by the context (*e.g.* presence of a tonal accent or of a morpheme boundary.) In any case, this variability suggests that consonant gemination still needs to be systematically examined on the basis of a consistent phonetic study.

Table 1. The consonant inventory of Standard Somali

		labial	dental	retroflex	palatal	velar	uvular	pharyngeal	laryngeal
stops	[-voi]		t		t̪ (j)	k	q		ʔ (ʻ)
	[+voi]	b	d	d̪ (dh)		g			
fricatives	[-voi]	f	s		ʃ (sh)	x (kh)		ħ (x)	h
	[+voi]							ç (c)	
nasals	([+voi])	m	n						
approximants	([+voi])	w	l, r		j (y)				

Bendjaballah & Le Gac (2021) establishes that in Standard Somali, the contrast /C_i/ vs /C_iC_i/ is realized as a manner contrast, rather than a length contrast (*cf.* also the recordings made available as Bendjaballah & Le Gac 2022a). This results from the analysis of a production experiment based on a controlled corpus targeting the realization of intervocalic /b, d, g/ and /bb, dd, gg/ in nouns. The corpus was produced by four speakers from Somalia (the Hiiraan region and Mogadishu), who considered themselves speakers of the ‘standard’ variety of Somali. Seven parameters were examined, which correspond to the acoustic correlates that most frequently oppose singletons and geminates crosslinguistically: three temporal parameters (closure duration, release duration, duration of the preceding vowel) and four non temporal parameters (presence/absence of release, devoicing of the test stop, stop closure amplitude, release amplitude). The relevant acoustic characteristics of intervocalic /b, d, g/ and /bb, dd, gg/ are summed up in Table 2. Intervocalic /b, d, g/ are realized as short approximants, while /bb, dd, gg/ are realized as short voiced stops. It is striking to observe that the mean closure duration of /bb, dd, gg/ corresponds to that attested for singleton — and not geminate — stops crosslinguistically: it is about 50% shorter than the values reported for geminates in various languages (*e.g.* Ridouane 2007 for Berber, Lahiri and Lankamer 1988 for Turkish and Bengali).

Table 2. The acoustic realization of the contrast /C_i/ vs /C_iC_i/ in Standard Somali

	<i>closure duration</i>	<i>release</i>	<i>additional characteristics</i>
/b, d, g/	43.1 — 45.1 ms	none	no frication noise, high level of energy, formant structure
/bb, dd, gg/	72.7 — 88.7 ms	clear release burst	fully voiced

These results differ from those reported in Farnetani’s (1981) important study. What matters here is the relative duration of geminates as opposed to singletons. Farnetani (1981) reports much longer values for the closure duration of /bb, dd, gg/: 157 — 174 ms, as opposed to 49 — 71 ms for /b, d, g/. She concludes that the contrast /C_i/ vs /C_iC_i/ is realized as [β/b] vs [bː]: both duration and manner of articulation distinguish /C_i/ vs /C_iC_i/. We thus seem to witness a

diachronic evolution in the realization of the length contrast in Somali in two respects: in today’s Somali

a) the manner of articulation seems to be the primary cue distinguishing /C_i/ vs /C_iC_i/, with duration playing a less clear role: the contrast is realized as [β] vs [b]

b) /C_i/ are realized as approximants — not as fricatives, thus showing a higher degree of lenition.

We conclude that the lenition of intervocalic voiced stops continues to make progress in Standard Somali. Note that the situation in today’s Standard Somali seems to be comparable to that reported by Saeed (1982: 4) in Isha Baydhaba, a specific variety of Somali: “This process [= weakening of plosives] also affects geminates, reducing them phonetically to a single voiced plosive. In these cases, the fricative versus plosive contrast takes over the phonological distinction between single and double consonants”.

1.2 Djibouti Somali (Experiment 1-NOUNS)

We examine the realization of singleton vs geminate /b, d, g/ in Djibouti Somali against this background. The same corpus as the one used in Bendjaballah & Le Gac (2021) was produced by “SAA”, a male native speaker of Djibouti Somali, in his late 30’s, who currently lives in La Roche-sur-Yon, France and speaks Somali and French on a daily basis with his family, and the diaspora. The contexts used in Bendjaballah & Le Gac (2021) were all tested (*cf.* (1)), however for our purpose in this article, only the two contexts in (1.a) and (1.b) are relevant: LexC and LexCC, which correspond to intervocalic singleton and geminate /b, d, g/ in nouns, with no morpheme boundary intervening between the surrounding context and the target consonant. We will provide the results for all contexts, so that the interested reader can compare them with the ones obtained for Standard Somali in Bendjaballah & Le Gac (2021).

(1)	Contexts (all intervocalic)		
a)	stem-internal singleton (LexC)	[li h aaxyo] _N	‘lions’
b)	stem-internal geminate (LexCC)	[dhi bb aannadiisii] _N	‘his wounds’
c)	compound (Cmp)	[cilmi _{N1} - h aaaris _{N2}] _N	‘scientific research’
		science-research	
d)	indefinite genitive (Gen)	[[bateri] _{Head} [h aabuur] _{Mod}] _{NP}	‘car’s battery’
		battery car	
e)	subject object (Ind)	[Cali] _{Sub} [Batuulo] _{Obj}	‘Ali (met) Batuulo’
		Cali Batuulo	

Contrarily to Bendjaballah & Le Gac (2021), where the speakers were recorded in one session, the Djibouti Somali speaker was recorded in several sessions. Like in Bendjaballah & Le Gac (2021), he produced at least 3 repetitions of each carrier sentences. The sentences were randomized and presented by the experimenter to the speaker one by one. The total number of items that was analyzed appears in Table 3. The list of the corresponding nouns is given in Appendix 1.

Table 3. Number of items

	LexC	LexCC	Cmp	Gen	Ind	total
b	18	19	18	17	20	92
d	21	16	25	12	17	91
g	23	11	28	49	16	127
total	62	46	71	78	53	310

For these items, three temporal parameters (closure, release duration, duration of the vowel preceding the test stop), and three non temporal parameters (presence/absence of release, devoicing of the test stop, stop closure amplitude) were examined. To evaluate the context and the consonant effect on the acoustic parameters (wherever relevant), we performed two-factor ANOVAs, with ‘Context’ and ‘Consonant’ as fixed factors, followed by post-hoc pairwise comparisons (Tukey). We now turn to the results of our observations on LexC and LexCC. We systematically start with the results concerning Djibouti Somali, and then compare them with those obtained for Standard Somali.

1.2.1 Temporal parameters

- **Closure duration (CD):** The measures for the target consonants appear in Figure 1 (see also Table A in the Appendix). For /b/ and /g/, LexCC is only slightly (9.5%-16.5%) longer than LexC; for /d/, it is striking to note that LexCC is shorter (8%) than LexC. Overall, there is no significant difference LexC vs LexCC ($p_{\text{Tukey}} = 0.716$). The contrast between Djibouti Somali and Standard Somali is illustrated by the plot diagrams in Figure 1:

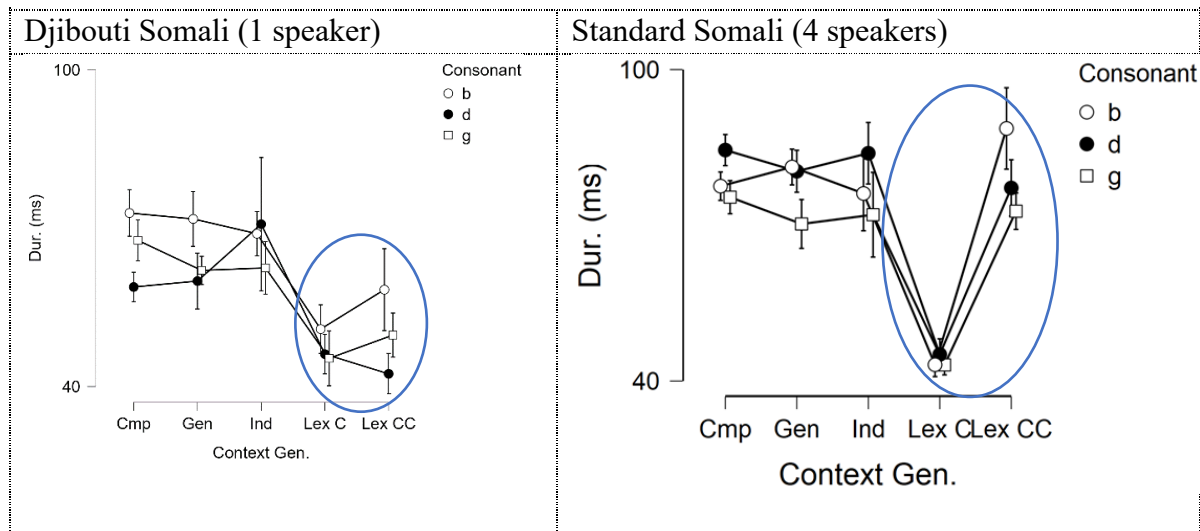


Figure 1. Closure duration

- **Release duration (RD):** 78.9% of LexC were produced without release burst. This does not come as a surprise: intervocalic singleton stops are lenited in Somali. However, 70% of LexCC were also produced without release burst. This contrasts with the situation

observed for Standard Somali where LexCC were always produced with a release burst (vs 94% of LexC were produced without release burst).

- **Vowel duration (VD):** Overall, there is no significant difference LexC vs LexCC ($p_{\text{Tukey}} = 0.627$). With respect to this parameter, Djibouti Somali behaves on a par with Standard Somali.

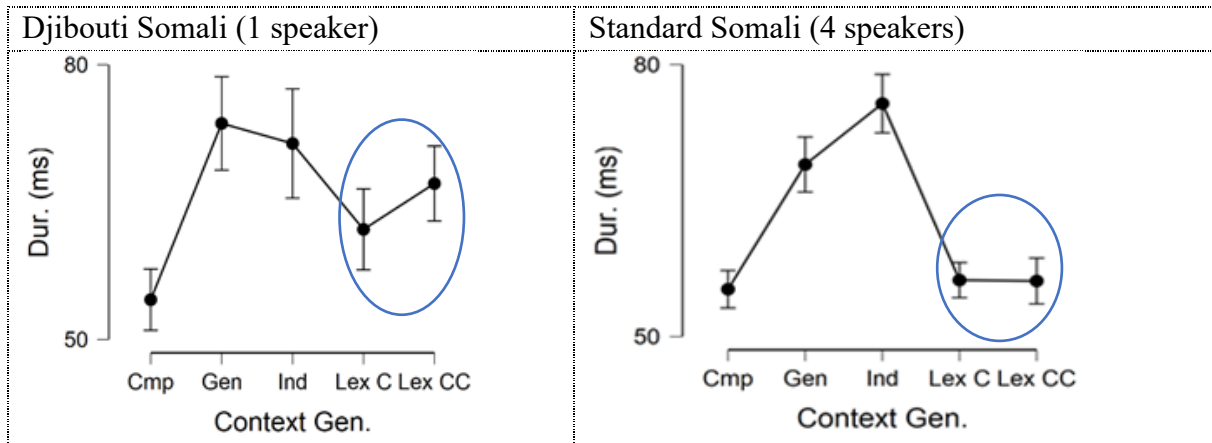


Figure 2. Vowel duration

To conclude, we found no significant difference between singleton and geminate /b, d, g/ in Djibouti Somali: in particular, there is no significant difference in the closure duration of singletons vs geminates, and no significant difference in the (non)realization of a release burst. This situation clearly contrasts with the one reported for Standard Somali.

1.2.2 Non-temporal parameters

- **Release burst:** LexCC like LexC, are realized as approximants. *cf.* our observations on release duration above.
- **Devoicing:** Our data reveal no devoicing in LexCC. Djibouti Somali patterns with Standard Somali.
- **Closure Amplitude (CA):** There is no significant difference between LexC and LexCC ($p_{\text{Tukey}} = 0.957$), and more generally between the various contexts that have been studied in Djibouti Somali. This situation contrasts with Standard Somali. Note also that CA of LexC and LexCC overall shows high values in Djibouti Somali. Those values are similar to those observed for LexC in Standard Somali, *i.e.* they correspond to approximants.

Djibouti Somali (1 speaker)	Standard Somali (4 speakers)
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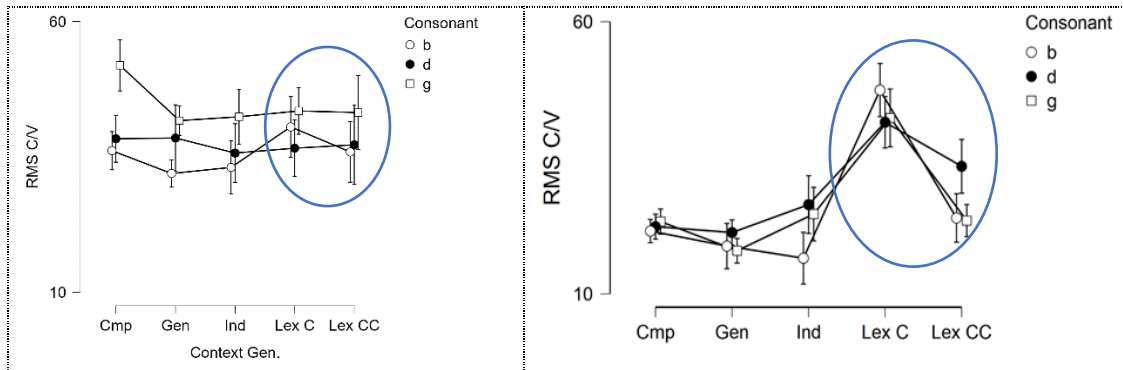


Figure 3. Closure Amplitude (%). CA was calculated as follows: the Root Mean Square (RMS) amplitude around the center of the closure portion was divided by the RMS of the center of the preceding vowel and multiplied by 100. See Bendjaballah & Le Gac (2021) for details.

1.2.3. Summary: singletons vs geminates in Djibouti Somali

Both /b, d, g/ and /bb, dd, gg/ are realized as short segments, and both series are realized as approximants: singletons vs geminates significantly differ neither in length, nor in manner of articulation. In other words, Djibouti Somali fully neutralizes the contrast singleton vs geminate at the phonetic level. This contrasts with Standard Somali, that opposes singletons and geminates at the phonetic level, via a manner contrast.

Table 4. Djibouti Somali: neutralization in intervocalic position

	/C _i / = /C _i C _i /
	[+voi]
[+lab]	[β]
[+dent]	[ð]
[+vel]	[ɣ]

1.3 Issues to be addressed

Our findings on the realization of Djibouti Somali /b, d, g/ and /bb, dd, gg/ raise several issues, both in phonetics and in phonology. First, at an empirical level, the results obtained in section 1.2 need to be confirmed by an additional experiment. Second, the question arises as to whether the neutralization of the contrast singleton vs geminate voiced stops that was observed at the phonetic level obtains at the phonological level. In order to answer this question, we need to examine the behaviour of the vowel following the test stops and to include the voiceless stops [t, k].

1.3.1. Testing ground: V~Ø alternation in CV_iCV_iC verbs/nouns

Barillot (2002), Barillot & Ségéral (2005) argue that intervocalic [t, k] are phonologically long. Their argument is based on the behaviour of C₁V_iC₂V_iC₃ verbs. In these verbs, the vowel located between C₂ and C₃ alternates with zero in well-defined environments. This is illustrated in (2.a) with the verb *gudub* ‘cross’. In the present 1sg, the stem is followed by the vowel-initial

suffix *-aa*, and no vowel surfaces between *d* and *b*. In the present 2sg, the stem is followed by the consonant-initial suffix *-taa*, and a vowel [u] is realized between *d* and *b*. The example in (2.b) shows that if the second stem-vowel is preceded by a CC-cluster, like in *hardaf* ‘gallop’, no V-zero alternation obtains: the present 1sg is *hardafaa*.

(2) V~∅ alternation in C₁V_iC₂V_iC₃ verbs

	Imperative 2sg	Present 1sg	Present 2sg	
a.	gud <u>u</u> b	gudbaa	gud <u>u</u> btaa	‘cross’
b.	hard <u>a</u> f	hard <u>a</u> faa	hard <u>a</u> ftaa	‘gallop’

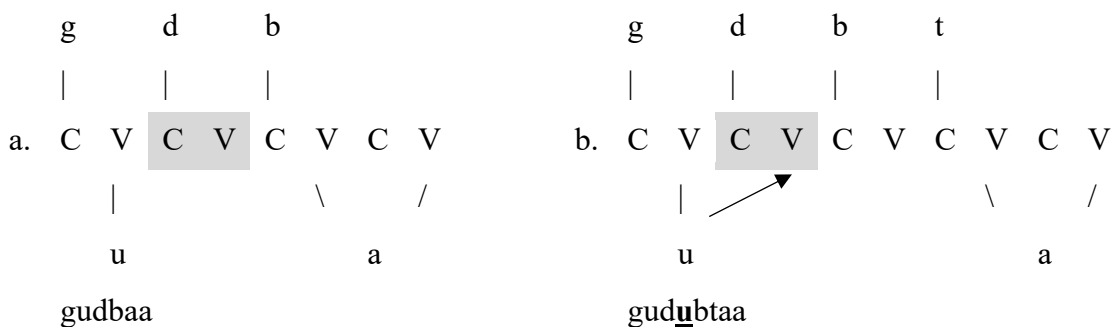
It turns out that C₁V_iC₂V_iC₃ verbs where C₂ = {t, k} do not pattern with *gudub*, rather they pattern with *hardaf*: e.g. the present 1sg of *tukub* ‘hink’ is *tukubaa*, not *tukbaa*. [t] and [k] behave on a par with a CC-cluster, not with a single C.

(3) “Exceptions”

	Imperative 2sg	Present 1sg	Present 2sg	
	tuk <u>u</u> b	tuk <u>u</u> baa	tuk <u>u</u> btaa	‘hink’
	mat <u>a</u> g	mat <u>a</u> gaa	mat <u>a</u> gtaa	‘vomit’

The analysis offered by Barillot (2002), and Barillot & Ségéral (2005) is based on the observation that Somali allows neither CCC-clusters, nor final CC clusters. They propose that C₁V_iC₂V_iC₃-verbs are underlyingly C₁V_iC₂∅C₃ (4.a), and that the stem vowel propagates on the position between C₂ and C₃ if its absence leads to an illicit CCC-cluster or to a final CC-cluster (4.b).

(4) /CVC∅C/, *CCC



C₁V_i{k,t}V_iC₃ verbs exhibit no V~∅ alternation. This implies that there is an underlying CC cluster to the left of V_i, like in *hardafaa*. [k] in *tukub* is always followed by a vowel because [k] is phonologically long. The parallelism between /tukub/ and /hardaf/ is illustrated in (5).

(5) /CVC₂C₂∅C/



they bear a tonal accent, which might have an effect on the realization of the surrounding consonants (e.g. singular *gabádh* ‘girl’, plural *gabdhó*).²

The verb selection was based on the standard dictionary by Zorc & Osman (1993). We first constituted a list of all CV_i{b, d, g, t, k}V_iC and CV_i{bb, dd, gg}V_iC verbs and checked them with a native speaker of Djibouti Somali. We selected only those items that were productively used by the speaker. We kept the vocalic environment constant in both groups of verbs as much as possible. We arrived at a restricted number of verbs.³ As a result, the 16 items shown in Table 5 were selected for the experiment.

Table 5. Verb selection

		Total (Zorc & Osman)	Selected	
a.	/b(b), d(d), g(g)/			
	C ₁ V _i bV _i C ₃	18	2	dabar ‘hobble (camel), fetter’ kibir ‘be arrogant’
	C ₁ V _i bbV _i C ₃	4	3	dabbaq ‘apply’ ku soo tabbac ‘raise’ dibbir ‘be full, have eaten too much’
	C ₁ V _i dV _i C ₃	20	3	hadal ‘talk’ godol ‘prepare the bed’ tidic ‘braid’
	C ₁ V _i ddV _i C ₃	9	2	baddal ‘change’ qaddac ‘boycott’
	C ₁ V _i gV _i C ₃	6	1	leged ‘throw someone to the ground’
	C ₁ V _i ggV _i C ₃	4	1	gaggab ‘faint’
b.	/t, k/			
	C ₁ V _i tV _i C ₃	7	2	fatah ‘overflow, be very talkative’ matag ‘vomit’
	C ₁ V _i kV _i C ₃	8	2	feker ‘think’ tukub ‘walk weakly’
		76	16	

The carrier sentences were designed so as to avoid any potential focal prominence in the environment of the test stop, and had a structure comparable to that used in Bendjaballah & Le Gac (2021), using the focus particle *waxaa*: [X *waxaa* verb NP]. *Waxaa* is a focus particle that

² Tonal accent is absent in the nominative of indefinite nouns, but some speakers are reluctant to accept sentences with indefinite nouns in the nominative. In addition, Experiment 1 revealed that some speakers may well realize nominative nouns with a tonal accent.

³ Given the scarcity of the data, we had to consider verbs with C₃ = [+guttural], which we know tend to trigger V-propagation (and transparency), e.g. /madaḥ-ta/ → [madaḥada] ‘the heads, leaders’. However, since the target vowel is located to the left of C₃, we consider that this fact does not interfere in any relevant way.

focuses the *last* constituent of the sentence, *i.e.* the post-verbal NP in our carrier sentences. Finally, the position of the target consonant was kept constant, as the onset of the 7th syllable. The sentences used in the experiment are exemplified in Table 6.

Table 6. Carrier sentences.

	/C/	verb	
a.	b	dabar	Adigu waxaad dab <u>ab</u> artay awrkii da'da weynaa. <i>You fettered the old camel.</i>
		kibir	Adigu waxaad ki <u>ib</u> irtay in badan. <i>You were very arrogant.</i>
	bb	dabbaq	Adigu waxaad dab <u>bb</u> aqday siyaasaddii madaxweynaha. <i>You applied the political program of the president.</i>
		tabbac	(Adigu) Waxaad ugu soo tab <u>bb</u> acday si uu u faraxsanaado. <i>You raised him so that he will be happy.</i>
		dibbir	Adigu waxaad di <u>bb</u> irtay ilaa iyo intuu yimid. <i>You ate too much from the moment on he arrived.</i>
b.	d	hadal	Adigu waxaad had <u>ad</u> ashey hadallo been been ah. <i>You talked lies.</i>
		godol ⁴	Adigu waxaad god <u>od</u> oshey sariirteedii. <i>You prepared her bed.</i>
		tidic	Adigu waxaad ti <u>id</u> icday timeheegii. <i>You braided her hair.</i>
	dd	baddal	Adigu waxaad bad <u>dd</u> ashay khaanadihii. <i>You changed the shelves.</i>
		qaddac	Adigu waxaad qad <u>dd</u> acday shirkii. <i>You boycotted the meeting.</i>
c.	g	leged	Adigu waxaad leg <u>ed</u> dey walaasheed. <i>You threw your sister to the ground.</i>
	gg	gaggab	(Adigu) Shaley waxaad u gag <u>gg</u> abtey si kedis ah. <i>Yesterday you suddenly fainted.</i>
d.	t	fatah	Adigu waxaad fat <u>ah</u> day shaley. <i>You were very talkative yesterday.</i>
		matag	(Adigu) Xaley waxaad u ma <u>ta</u> gtay si kedis ah. <i>Yesterday evening you suddenly vomited.</i>
e.	k	tukub	Adigu waxaad tu <u>k</u> ubtay shaley. <i>You were walking weakly yesterday.</i>
		feker	(Adigu) Shaley waxaad ka fe <u>k</u> ertey casharkii. <i>Yesterday you thought about the lesson.</i>

⁴ In Standard Somali the verb 'prepare the bed' is *gogol*. However the Djibouti Somali speakers we consulted uniformly used *godol* instead.

For all verbs in the corpus, we tested both forms with a V-initial inflectional suffix (*i.e.* the 1s/3ms *-aa*, and 3p *-aan*) and with a C-initial suffix (*i.e.* the 2s/3fs *-taa*, the 1p *-naa*, and the 2p *-taan*).

2.2 The experiment

The Djibouti Somali native speaker who performed the production experiment summarized in section 1.2. ('SAA') was recorded in one session in March 2022 in La-Roche-sur-Yon (France).

Each sentence of the corpus was transcribed in the standard Somali orthography, and reproduced on a slide in a Powerpoint document (*cf.* Figure A in the Appendix). The speaker was first exposed to a written sentence with a verb form including a C-initial suffix, *i.e.* with a context where no V~∅ alternation is expected to obtain. Then, he was exposed to the beginning of a new sentence, with an independent pronoun, and he was asked to complete the sentence according to the model available in the preceding sentence (the priming sentence was still visible on the screen), *e.g.*

- (6) Priming sentence: Adigu waxaad dabartay awrkii da'da weynaa.
You fettered the old camel.
Elicited sentence: Anigu waxaan...
I...

For each verb, all inflectional forms were recorded (1s, 2s, 3ms, 3fs, 1p, 2p, 3p) according to this pattern.

The experiment was preceded by a training module in which only verbs that do not exhibit any V~∅ alternation were selected, *e.g.* *keen* "bring" as shown in (7):

- (7) Priming sentence: Adigu waxaad keentay qalin cusub.
You brought a new pen.
Elicited sentence: Anigu waxaan...
I...

2.3 Results

In this section, we will systematically compare the results of Experiment 2-VERBS with those obtained in Experiment 1-NOUNS. In particular, we aim at determining whether the contrast C₂ vs C₂C₂ is fully neutralized at the phonetic level in Djibouti Somali. It is important to bear in mind that the nouns selected in Experiment 1-NOUNS did not have the same phonological structure, in particular the test consonants were surrounded by two different vowels (*i.e.* *a*) while the verbs in Experiment 2-VERBS all have the same phonological structure (CVC(C)∅C).

2.3.1 /b(b), d(d), g(g)/

The acoustic properties of intervocalic C₂ and C₂C₂ can uniformly be examined in the inflectional forms that include a consonant-initial suffix (*i.e.* 2s/3fs, 1p, and 2p, *e.g.* *kibirtay*

‘you were / she was arrogant’ and *dibbirtay* ‘you/she ate too much’). Table 7 gives the number of singleton and geminate consonants analyzed in these forms. The forms including a vowel-initial suffix (*i.e.* 1s/3ms and 3p) were considered in order to establish whether a vowel was realized after C₂(C₂).

Table 7. Number of tokens taken into account in the acoustic analysis (2s/3fs, 1p, 2p)

	b	d	g	Total
Singleton	16	24	8	48
Geminate	24	17	8	49
Total	40	57	32	129

We investigate the following parameters: Closure Duration (CD), the presence of a release burst, and voicing (in order to decide whether geminates are realized as partially or fully voiced segments). Intensity will not be taken into account. Indeed, the vowels surrounding the target consonants could not be consistently controlled as there were not enough CV₁C₂C₂V₁C verbs. Consequently, intensity could not be normalized and used to compare the target consonants. In addition, we saw in section 1.2 that there is no significant difference between LexC and LexCC, as far as closure amplitude is concerned. In fact, closure amplitude does not constitute a relevant parameter because it depends upon closure duration and/or does not vary in function of the context.

- **Phonetic realisation of /b(b), d(d), g(g)/**

The mean closure duration (CD) values appear as descriptive plots in Figure 4 below.

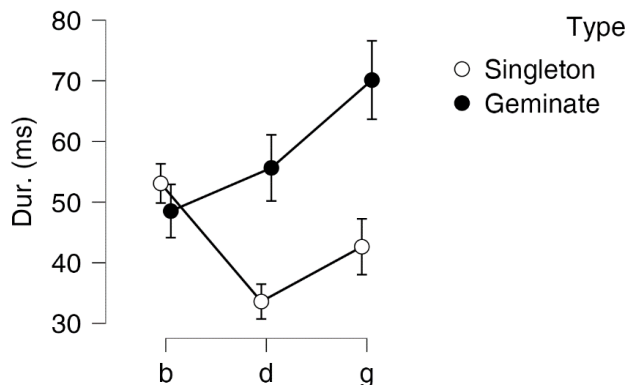


Figure 4. Plots for mean closure duration (ms) with confidence interval (95%)

There are two striking differences as compared to the results obtained for Djibouti Somali nouns in Experiment 1-NOUNS:

- i. /dd, gg/ have a longer CD than their singleton counterparts /d, g/ (*ca.* +67%).
- ii. /g(g)/ is realized with a longer CD than /d(d)/.

SAA thus patterns with Standard Somali speakers in distinguishing between /dd, gg/ and /d, g/ at the phonetic level. However, contrarily to Southern Standard speakers, he produces /g/ and /d/ with different CD, whereas Standard Somali speakers produced /b, d, g/ with a similar CD.

In having similar values for CD (*ca.* 50 ms), /b/ and /bb/ clearly stand out. Note that this peculiar behaviour cannot be ascribed to a lack of data for /b(b)/ since the corpus contains a comparable number of tokens for /b(b)/ and /d(d)/. Note that the neutralization of the opposition /b/ vs /bb/ takes place in favour of the geminate: /b/ shows values that are typical of geminates elsewhere (with CD higher than 30/40 ms).

We now turn to the manner of articulation, and voicing. Three types of consonants were produced by SAA:

- i) Approximants: fully voiced, with no release burst; they display a formant structure with a high level of energy; *cf.* Figure 5.A;
- ii) Voiced stops: fully voiced, like the approximants, but with a release burst and much less energy than the approximants (Figure 5.B);
- iii) Partially devoiced stops, during which voicing stops before the release burst (2 tokens).

The number of approximants and fully/partially voiced stops for each target consonant are shown in Table 8.

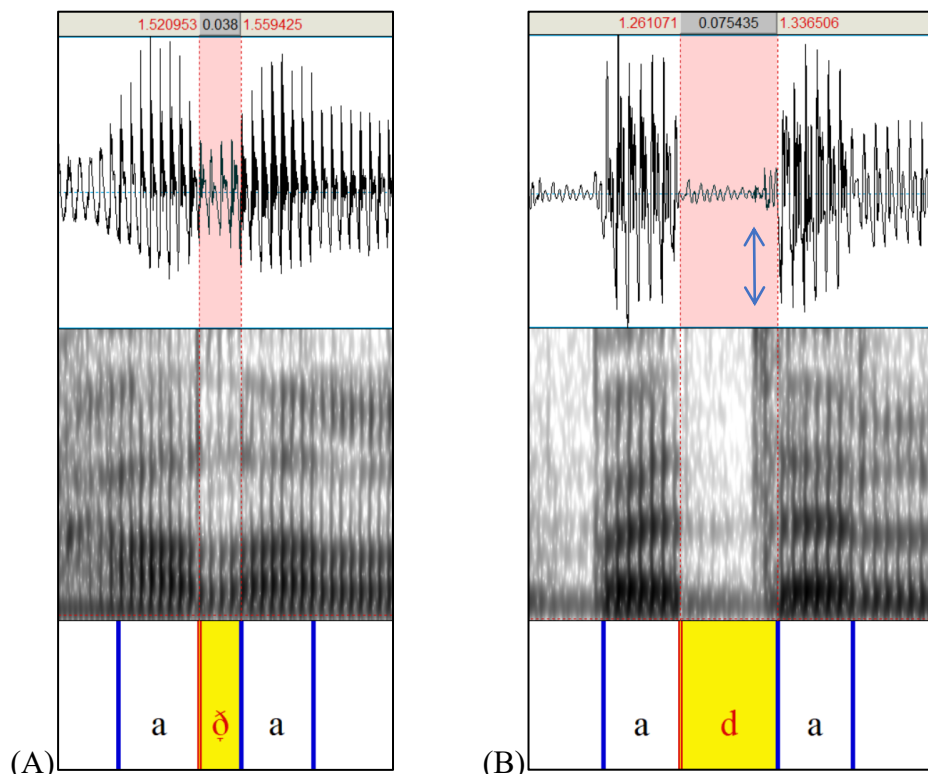


Figure 5. Speech signals with spectrograms displaying typical realizations of the approximant [ɔ̃] /d/ in *hadallay* “we spoke” (A), and of the fully voiced stop [d] /dd/ in *baddallay* “we changed” (B). The arrow indicates the release burst. Voicing occurs during the closure and continues in the release.

Table 8. Number of realisations as approximants and fully/partially voiced stops for each target consonant

		Manner and voicing			
		Approximant	Fully voiced stop	Partially devoiced stop	Total
b	Singleton	11	5	0	16
	Geminate	10	14	0	24
	Total	21	19	0	40
d	Singleton	22	2	0	24
	Geminate	0	15	2	17
	Total	22	17	2	41
g	Singleton	7	1	0	8
	Geminate	0	8	0	8
	Total	7	9	0	16
Total	Singleton	40	8	0	48
	Geminate	10	37	2	49
	Total	50	45	2	97

In Experiment 1-NOUNS (section 1.2), singleton and geminate consonants were mainly (70-78%) realised as approximants by SAA, regardless of the place of articulation. In Experiment 2-VERBS, at a general level, the picture is different: singletons were produced as **approximants** in 83.3% of the cases (40/48), whereas geminates were realized as fully **voiced stops** and partially devoiced stops in 79.6% of the cases (37 voiced stops + 2 partially devoiced stops = 39/49).

A closer look at the data reveals that /dd/ and /gg/ are *always* realised as stops (100%) whereas /d/ and /g/ almost always surface as approximants (90.6%: 29/32). This result is consistent with the observations made for CD. We conclude that SAA produces /dd, gg/ as **short stops** ([d, g]) and /d, g/ as approximants ([ð, ɣ]), just like Standard Somali speakers do.

By contrast, our results show a much less clear distribution between approximants and stops for /b(b)/: /b/ is realised as the voiced stop [b] in 5/16 items (31.3%) whereas /bb/ surfaces as the approximant [β] in 10 out of 24 cases (41.7%). In other words, the only geminates that are realized as approximants are /bb/. This shows that the opposition /b/ vs /bb/ has a particular status in SAA's system, moving towards a neutralisation at the phonetic level, both for CD and manner.

We now turn to the question of the length contrast at the phonological level. How does the vowel located after the singletons and the geminates behave?

- **Behavior of the V located after C₂ vs C₂C₂**

The relevant forms are those that include a vowel-initial suffix (see section 2.1), *i.e.* the 1s/3ms and 3p verb forms. In these forms, a vowel is expected to occur after a (phonological) geminate, *e.g.* *dibbiray* ‘I/he ate too much’, but not after a singleton, *e.g.* *kiboray* ‘I/he was arrogant’. Table 9 gives the number of verb forms with (“V”) and without (“ø”) a vowel after C₂ vs C₂C₂.

Table 9. Realization of a vowel after C₂ vs C₂C₂ (1s/3ms, 3p)

		ø	V	Total
b	Singleton	12	0	12
	Geminate	3	15	18
	Total	15	15	30
d	Singleton	12	6	18
	Geminate	0	13	13
	Total	12	19	31
g	Singleton	6	1	7
	Geminate	0	6	6
	Total	6	7	13
Total	Singleton	30	7	37
	Geminate	3	34	37
	Total	33	41	74

Phonological singletons and geminates are in a nearly complementary distribution: there is almost always a vowel after a geminate (34/37) whereas no vowel occurs after a singleton in 81% of the items (30/37). In other words, geminates do behave like geminate consonants at the phonological level despite the fact that /dd, gg/ are phonetically realised as short stops and /b/ and /bb/ tend to be phonetically neutralised.

Note however that, in 3 cases, no vowel occurs after /bb/. This might indicate that the contrast /b/ vs /bb/ begins to be lost at the phonological level, too.⁵ Finally, the 6 vowels appearing after /d/ all occur in *tidic* /tidiʕ/. These unexpected vowels are induced by the pharyngeal /ʕ/: *tidcay* /tidʕaj/ → [tidʕaj], *cf.* note 3.

2.3.2 /tt, kk/ (vs /dd, gg/)

We now turn to the phonetic realisation of the intervocalic voiceless stops /tt, kk/. We will systematically compare them with their voiced counterparts /dd, gg/ in all inflectional verb forms.

- **Phonetic realisations of /tt, kk/**

We start with the manner of articulation and voicing. *All* instances are realised as **voiceless stops**: a release burst is systematically produced and no voicing occurs during the closure.

⁵ Some dictionaries, *e.g.* Zorc & Osman (1993), give both *dabbaq* and *dabaq* ‘apply’. The 3 exceptional forms however are not due to this potential variation, since they all occur with the verb *tabbac* ‘raise’.

Figure 6 provides an example of such a realization for /tt/. There is thus a systematic difference in the realization of the voiced series /dd/, /gg/ (cf. Figure 5.B above) and the voiceless series /tt/, /kk/.

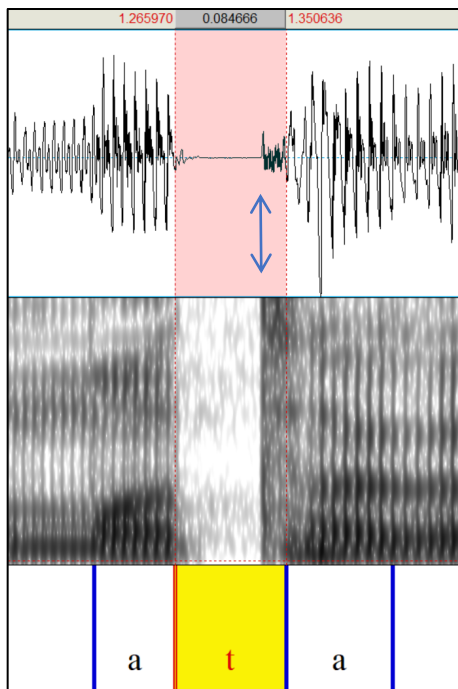


Figure 6. Speech signal with spectrogram displaying a typical realization of /tt/ in *matagay* ‘I vomited’. The arrow indicates the release burst; it is followed by frication noise up to the voice onset of the following vowel (VOT). Before the release, the closure is characterized by silence, without voicing.

The mean closure duration (CD) values for /dd, gg/ and /tt, kk/ appear as descriptive plots in Figure 7.

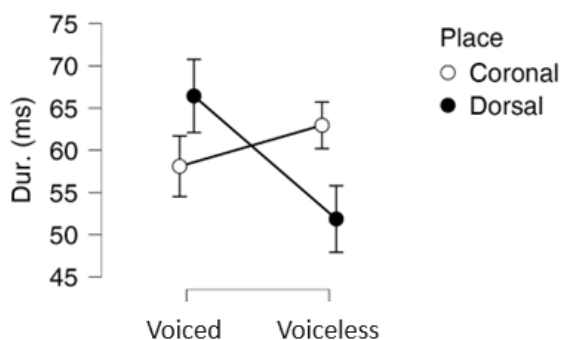


Figure 7. Closure duration for /dd, gg/ (Voiced) and /tt, kk/ (Voiceless)

Figure 7 reveals an intricate pattern. The coronal and the dorsal stops clearly behave differently. An asymmetry arises when we compare segments that share the same specification for voice:

- i) As seen above in section 3.1.1, /dd/ has significantly shorter CD values than /gg/ (58 ms vs 66 ms; $p_{\text{Tukey}} < .01$).

- ii) By contrast, /tt/ has significantly *longer* CD values than /kk/ (63 ms vs 52 ms; $p_{\text{Tukey}} < .001$).

Comparing the segments that share the same specification for place does not reveal a clear picture, either:

- i) /tt/ has a longer CD than /dd/, but this slight difference is not statistically significant (63 ms vs 58 ms; $p_{\text{Tukey}} = .1652$)
- ii) For the dorsal stops, we observe the opposite pattern: /kk/ has a significantly shorter CD than /gg/ (52 ms vs 66 ms; $p_{\text{Tukey}} < .001$).

At this stage, we have no explanation for this intricate pattern.

/tt, kk/ are characterized by a release burst followed by a short frication noise up to the voice onset of the subsequent vowel. The time interval during which this frication noise obtains is the Voice Onset Time (see, a.o. Lisker & Abramson 1964; Ladefoged & Johnson 2010; Cho & Ladefoged 1999). However, the boundary between the end of the burst and the frication noise often was indistinguishable in our data. As a result, release duration (RD) was defined as the temporal interval between the onset of the release burst and the beginning of the following vowel, *i.e.* RD encompasses the duration of the release burst and that of the VOT for the voiceless stops. A similar measurement was done for the voiced geminates⁶. Mean RD values for /dd, gg/ and /tt, kk/ are reported in Figure 8:

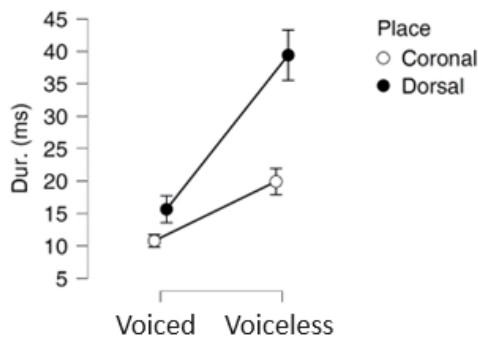


Figure 8. Mean release duration of /dd, gg/ (Voiced) and /tt, kk/ (Voiceless)

/tt, kk/ have a longer RD than /dd, gg/; this difference is significant both for the coronal and the dorsal stops ($p_{\text{Tukey}} < .001$). This result is consistent with what has been described for other languages (see for example Ridouane (2007: 129), who reports a longer RD for voiceless stops than for voiced stops in Tashlhiyt Berber, be they singletons or geminates).

Within the voiced series, the difference between /dd/ and /gg/ is not significant ($p_{\text{Tukey}} = .0881$). By contrast, in the voiceless series, the RD value for /tt/ is significantly lower than that for /kk/ ($p < .001$). This result is also consistent with what has been observed for similar places of articulation in other languages (*cf.* Lisker & Abramson 1964; Ladefoged & Maddieson 1995).

⁶ Technically, voiced stops have a VOT with a *negative* value because voicing begins *before* the release burst (see Ladefoged *ibid.*). Voiceless stops typically display a *positive* VOT because the voice onset is located *after* the release burst.

As mentioned above, the VOT itself could not be measured for /tt/ and /kk/. However, the values for the mean RD could be measured. These values (19.9 ms for /tt/ and 39.4 ms for /kk/) correspond to the VOT of unaspirated /tt, kk/ in languages like Eastern Armenian and Thai, which have three contrastive phonation types for stops: voiced, unaspirated voiceless and aspirated voiceless stops (*cf.* Lisker & Abramson 1964). We conclude that word-internal /tt, kk/ are not realized as aspirated stops in Djibouti Somali.

Finally, we calculated the *total duration* (TD) of /dd, gg/ and /tt, kk/, by adding CD and RD. The resulting values are reported in Figure 9. As expected, /dd, gg/ are significantly shorter than /tt, kk/ ($p_{\text{Tukey}} < 0.01$). In addition, it turns out that TD provides a more coherent pattern than the intricate one found for CD alone: TD of coronal stops is consistently shorter than TD of velar stops.

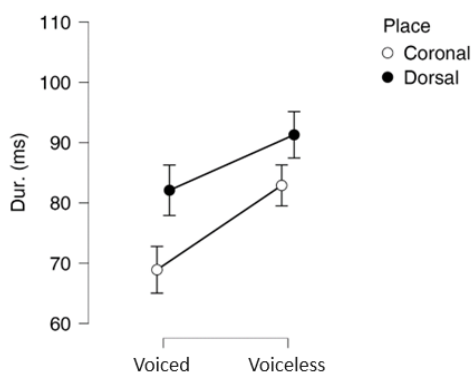


Figure 9. Mean Total duration (CD +RD) of /dd, gg/ (Voiced) and /tt, kk/ (Voiceless)

TD for /tt/ and /kk/ in Experiment 2-VERBS is substantially shorter than the sole CD of the voiced geminates reported in Farnetani (1981). It is shorter than the TD values reported for voiceless geminates in various languages in similar context (see Table 10 below). In fact, TD of /tt, kk/ as produced in Experiment 2-VERBS is even shorter than the values reported for voiceless singleton stops crosslinguistically. In sum, despite the fact that /tt, kk/ are significantly longer than /dd, gg/, they are to be considered as voiceless **short** stops at the phonetic level, *i.e.* [t, k].

Table 10. Comparison TD of /tt, kk/ in Djibouti Somali and elsewhere.

TD Djibouti Somali (Experiment 2-VERBS)	/tt/	81.9 ms	
	/kk/	91.3 ms	
Mean CD Somali (Farnetani 1981)	/bb, dd, gg/	157-174 ms	
		voiceless C _i C _i	voiceless C _i
TD Tashlhiyt Berber (Ridouane 2007)		188 ms	102 ms
TD Turkish (Lahiri & Hankamer 1988)		210 ms	105 ms
TD Bengali (Lahiri & Hankamer 1988)		251 ms	157 ms

- **Behavior of the V located after /tt, kk/**

SAA always produces a vowel after [t, k] (*i.e. matagay, *matgay*) just like he does after the voiced geminates /dd, gg/. This means that phonetically short [t, k] behave like geminates at the phonological level.

2.3.3 Experiment 2-VERBS: Conclusion

The results obtained in Experiment 2-VERBS differ from those obtained in Experiment 1-NOUNS. Experiment 1-NOUNS revealed that SAA neutralizes the contrast between singletons and geminates for all places of articulation. In Experiment 2-VERBS, SAA clearly realises a phonetic contrast between /d, g/ and /dd, gg/; only the opposition /b/ vs /bb/ is neutralized at the phonetic level. This suggests that the labial consonants might have a particular status in SAA's system. As for the voiceless stops, the acoustic analysis has shown that SAA realises /tt, kk/ as *short* voiceless stops. The phonetic realisations of the target consonants produced by SAA in Experiment 2-VERBS are summarized in Table 11.

Table 11. Experiment 2-VERBS: summary

	V_V		
	/C _i /	/C _i C _i /	
	[+voi]	[+voi]	[-voi]
labial ([+lab])	[β] (68.7%) [b] (31.3%)	[β] (41.7%) [b] (58.3%)	
coronal ([+dent])	[ḍ]	[d]	[t]
dorsal ([+vel])	[ɣ]	[g]	[k]

At the phonological level, the behaviour of the vowel located after C₂(C₂) has shown that the contrast between /b, d, g/ and /bb, dd, gg/ is maintained even if /dd, gg/ are realised as the short stops [d, g] and /b/ and /bb/ tend to be phonetically neutralised. Similarly, the systematic realization of the vowel after [t, k] confirms that /tt, kk/ are underlying geminates.

3 Conclusion

In this article we aimed at contributing to a better understanding of the diatopic variation (and to a certain extent, of diachronic change) in Somali. To this effect, we provided the results of two production studies targeting the realization of singleton and geminate stops by a Djibouti Somali speaker. This analysis was conducted against the background of a preceding study on the same topic conducted with Standard Somali speakers (Bendjaballah & Le Gac 2021).

In Bendjaballah & Le Gac (2021), we showed that, in Standard Somali, short voiced stops are systematically lenited with a higher degree of lenition than reported in the 1980's: in today's Somali, they are realized as approximants, not as fricatives. We also established that geminate voiced stops are lenited to *short* voiced stops. At the phonetic level, the primary correlate of gemination is not duration but the manner of articulation. We are thus facing a lenition path in intervocalic position, as largely attested cross-linguistically.

The results of the two production experiments described in this article suggest that, in Djibouti Somali, lenition goes one step further. The first experiment shows that the contrast singleton *vs* geminate is fully neutralised at the phonetic level in nouns, with a realization as approximants for both series of segments. The second experiment shows that in CVCøC-verbs, the coronals and the dorsals oppose singletons to geminates via a manner contrast, as was the case in Standard Somali. This contrast however is neutralised for the labials. In order to explain this contrast, rather than assuming a category-specific phonology, we would like to suggest that the difference in the phonetic realization of the target consonants is to be ascribed to a difference in the underlying structure of the items selected in Experiment 1-NOUNS *vs* Experiment 2-VERBS: ...i_a... *vs* ...V_ø respectively. An experiment on CVCøC-nouns will be designed in a further study to assess the validity of this conjecture.

As for the underlyingly long voiceless stops, we argued that their acoustic properties correspond to those reported for short non aspirated stops in other languages. This can also be interpreted as a lenition process.

To sum up, the realization of stops does not involve phonetic duration in today's Somali. Our second aim was to decide whether those short stops (both voiced and voiceless) are still phonologically long. We tested their phonological representation by examining the presence *vs* absence of the following vowel. We concluded that the opposition singleton *vs* geminate still obtains at the phonological level. We are therefore in a position to conclude in favour of an extension of geminate latency in Somali: geminate latency does not only concern the voiceless stops (as established by Barillot (2002) and Barillot & Ségéral (2005)) but also the voiced stops. We conclude with a short note on the labials. The results obtained for /b/ *vs* /bb/ were less clear-cut: there, the opposition singleton *vs* geminate is fully neutralized at the phonetic level (both are realized as approximants), and seems to be neutralized at the phonological level in some items, too. In other words, geminate latency tends to disappear in the labial series. This suggests that labials might have a special status in the system, maybe due to the fact that among the stop series, they are the only ones without any voiceless counterpart.

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Appendix

Appendix 1. List of the nouns with lexical singleton (LexC) and geminate (LexCC) consonants used in Experiment 1-NOUNS

LexC

/b/	dhibaatooyinkani	‘these problems’
	Hibaaqi	‘Hibaaq (name)’
	hibasho	‘unforgettable events’
	jibaallo	‘roofs’
	libaaxyo	‘lions’
	tibaaxyo	‘unconfirmed news’
/d/	gidaarro	‘walls’
	faaqidayaal	‘researchers’
	dhidarro	‘spotted hyenas’
	ciidammo	‘military troops’
	idaacaddani	‘this broadcast’
	ciidagale	‘a reptile’
/g/	sigaryo	‘cigarettes’
	cigaallo	‘turbans’
	Cigaal	‘Cigaal (name)’

xigaalo	<i>'close relatives'</i>
digaagad	<i>'a chicken'</i>
fiigayaal	<i>'wild animals'</i>

LexCC

/bb/	dhibbaannadiisii	<i>'his wounds'</i>
	jiriibbanno	<i>'quarrels'</i>
	gibbaanno	<i>'livestock (giving little milk)'</i>
	jibbaar	<i>'exponent'</i>
	shibbanayaal	<i>'consonants'</i>
/dd/	biddayaal	<i>'slaves'</i>
	ciddalayaal	<i>'owners'</i>
	riddaaminta	<i>'the act of raising (something heavy)'</i>
	iddaaradu	<i>'the management'</i>
	ciddabbixista	<i>'the end of the legal waiting period in which a Muslim woman cannot re-marry'</i>
/gg/	higgaadda	<i>'the spelling out'</i>
	miigganaantiisa	<i>'his honesty'</i>

Table A. Experiment 1-NOUNS: mean Closure Duration (ms) and Standard Deviation in parentheses

	LexC	LexCC	Cmp	Gen	Ind
b	50.9 (9.6)	58.4 (16.1)	72.9 (6.9)	71.8 (10.1)	69.0 (8.2)
d	46.1 (8.0)	42.4 (7.2)	58.9 (6.8)	60.0 (7.9)	70.8 (21.8)
g	45.4 (10.5)	49.7 (5.0)	67.7 (7.8)	62.0 (7.9)	62.5 (10.0)

Table B. Experiment 1-NOUNS: mean Vowel Duration (ms) and Standard Deviation in parentheses

	Lex C	Lex CC	Cmp	Gen	Ind
b, d, g	62.0 (14.9)	67.0 (12.9)	54.4 (12.7)	73.6 (20.4)	71.4 (19.6)

Table C. Experiment 1-NOUNS: mean Closure Amplitude (%) and Standard Deviation in parentheses

	Lex C	Lex CC	Cmp	Gen	Ind
b	40.53 (11.72)	35.90 (11.63)	36.14 (5.55)	31.92 (4.85)	33.05 (9.49)
d	36.59 (11.10)	37.22 (13.72)	38.34 (10.47)	38.48 (9.13)	35.70 (9.38)

g	43.48 (8.64)	43.19 (8.20)	51.90 (9.52)	41.69 (8.03)	42.40 (10.18)
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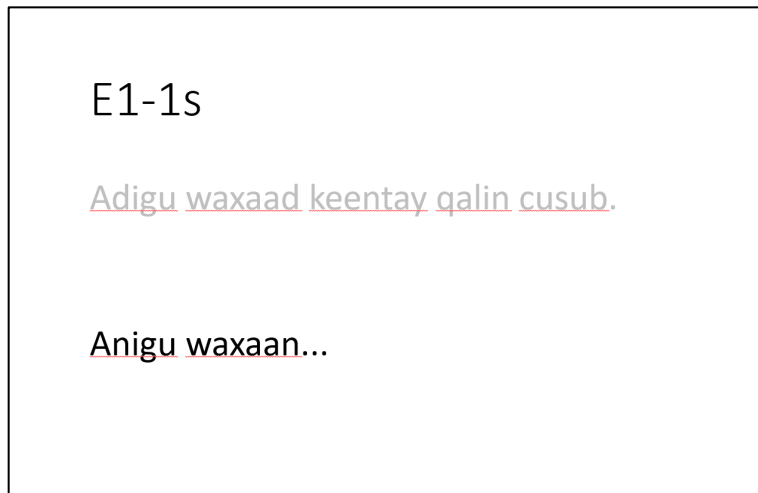


Figure A. Experiment 2-VERBS: Example of a slide of the training module.

Table D. Experiment 2-VERBS: mean CD (ms) with Standard Deviation (SD) and number of items (N)

		Mean CD	SD	N
b	Geminate	48.5203	10.3898	24
	Singleton	53.0842	6.0572	16
d	Geminate	55.6432	10.6012	17
	Singleton	33.6077	6.7784	24
g	Geminate	70.1237	7.7213	8
	Singleton	42.6405	5.5141	8

Table E. Experiment 2-VERBS: mean CD (ms), Standard Deviation (SD) and number of items (N) (all inflectional forms)

	Place	Mean CD	SD	N
Voiced	Coronal /dd/	58.1035	9.6027	30
	Dorsal /gg/	66.4337	7.5035	14
Voiceless	Coronal /tt/	62.9622	7.0922	28
	Dorsal /kk/	51.8653	10.1495	28

Table F. Experiment 2-VERBS: mean RD (+VOT) (ms) with Standard Deviation (SD) and number of items (N) (all inflectional forms)

	Place	Mean RD	SD	N
Voiced	Coronal /dd/	10.7872	2.5802	30
	Dorsal /gg/	15.6468	3.6256	14
Voiceless	Coronal /tt/	19.9221	5.2524	28
	Dorsal /kk/	39.4162	10.0296	28

Table G. Experiment 2-VERBS: mean total duration (TD = CD+RD+VOT) (ms) with Standard Deviation (SD) and number of items (N) (all inflectional forms)

	Place	Mean TD	SD	N
Voiced	Coronal /dd/	68.8908	10.3799	30
	Dorsal /gg/	82.0805	7.2536	14
Voiceless	Coronal /tt/	82.8844	8.7903	28
	Dorsal /kk/	91.2815	9.9058	28