

Gemination in Amharic: Examination of the Duration of Amharic Consonants

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Abstract: This study investigated the duration of Amharic consonants. Three native speakers were recorded reading geminate and nongeminate Amharic words prepared in a list and durations were extracted using Praat. The results showed that Amharic consonants can be twice as long as singletons and word final consonants were found to be longer in word final position than in word medial position. Voiceless consonants were longer than voiced consonants in both word medial and word final positions as both geminates and singletons. However, there was no statistically significant differences between the duration of geminate voiced and voiceless consonants.

Introduction

Amharic is a South Ethio-Semitic language spoken in the central and northern parts of Ethiopia and in all towns of the country. It has more than 21 million first language speakers and more than 4 million second language speakers (Office of Population and Housing Census Commission (OPHCC) 1998), making it one of the most widely used language in the country. Besides Ethiopia, Amharic is also spoken in Israel by the Beta Israel (Felasha) community whose elder members were born and raised in Ethiopia as well as by over a million members of the diaspora in the US and elsewhere. It is the working language of the federal government, four regional states and two federal city administrations.

(Baye 2008)¹ identified 30 consonant phonemes including the labialized consonants /k^w/, /g^w/ and /k'^w/. These include plumonics /p, b, t, d, k, k^w, g, g^w, ʔ, m, n, ɲ, f, s, z, ʃ, ʒ, h, tʃ, dʒ, l, r, w, j/; and Ejectives /p', t', s', k', k'^w, tʃ', '²

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¹ All the dates are in G.C. even if some of the works are found in E.C.

² There is an additional sound to this list, /v/, which is found in borrowed words from foreign languages such /velo/ 'veil' and /villa/ 'villa'. In most cases /v/ is found in free variation with /b/ as

Except for /h/ and /ʔ/ all consonants can be geminated. Geminate consonants appear in word medial and final position contrastively with their nongeminate counterparts.

Previous works

Studies on Amharic so far focused mostly on syntax, followed by morphosyntax and morphology. Relatively few studies have been conducted on the suprasegmental aspects. Alemayehu (1987) studied the nature of lexical stress and claimed that Amharic has no phonemic stress. Alemayehu (1987:23) stated that Amharic “can be analyzed as an intonational (or a stress accent) language. Alemayehu claimed that the lexical stress of Amharic is realized by high pitch which falls on the penultimate syllable of the stem” Alemayehu (1987:37). (Wedekind and Wedekind 1994) concluded that there is phonetic stress in Amharic poetry. Both studies did not mention the role of geminate consonants or the relative length of the segments in stressed and unstressed syllables. Perhaps other additional experimental studies on the nature of stress in Amharic would answer questions related to the prominent aspect of Amharic stress and the role of sounds in stressed syllables in Amharic.

A study on the acoustics of Amharic stops reported the duration of Amharic stops and stated that velars had longer duration than alveolars for male subjects, and females’ stops were 1.23-1.63 times longer than males’ stops, (Derib 2011:89). However, the study did not include geminate stops.

Taddesse (2007) is so far the only person who did an experimental study on Amharic geminate stops that we are aware of. Taddesse (2007) claimed that his study focused on identifying the prominent feature that is responsible for Amharic word stress. However, the actual study focused on the difference between geminate

in /velo/ and / belo/ having the same meaning ‘veil’. The sound is not included in Amharic Phoneme list in the studies by Leslau (1969), Mullen (1986), Baye (1994, 2008, 2010).

and nongeminate consonants in Amharic. According to his study, voiced consonants had an average duration of 50 ms and voiceless consonants had an average duration of 70 ms. In a speech perception test he conducted to see the perceptual quality of the synthesized Amharic words that his speech synthesizer produced, an addition of 90 ms was found to be enough to consider the consonants geminate. This means that geminate voiced stops are at least 2.8 times longer than their nongeminate counterparts and voiceless stops are at least 2.285 times longer than their nongeminate counterparts.

There are several studies on the duration of consonants for languages spoken in Europe and America. Earliest studies such as Falc'un (1951) on Breton reported the duration of [l] to be 41.8 ms, [l:] 90 ms, [r] 26.9 ms and [r:] 49 ms. The data show that long consonants were more than 1.5 times longer and even more than twice longer than their shorter counterparts in the case of [l]. Umeda (1977) reported the duration of the consonants of American English in different contexts and concluded that number of syllables in a word, phrase-final position (if not followed by silence), and the type of vowel preceding or following the consonant did not have effect on the duration of consonants. He rather found the following six factors to have a significant effect on the duration of phonemes: (1) position of the consonant in the word, (2) its relation to lexical stress and morpheme boundary (if any) within the word, (3) whether it is in the postpausal position, (4) whether it is in the prepausal position, (5) content-function difference of the word, and (6) effect of adjacent consonant both inside the word and across the word boundary (Umeda 1977:848). However, since there are no phonemically geminate consonants in English, the results could not be compared with Amharic.

Ladefoged, P. (1996:91f.) state the following on the relationship between geminate and nongeminate stops:

In languages with a phonological contrast between long and short consonants, long stops have between one and a half to three times the acoustic closure duration of the short stops in careful speech.

Ladefoged and Maddieson's statement refers to stops and hence does not cover other sounds. The present study, however, includes fricatives, affricates, nasals, and approximants.

The present study

This study aims at investigating the duration of geminate and nongeminate consonants. The study tries to answer the following questions.

1. How long are geminate consonants compared with the nongeminate consonants?
2. Is duration of a consonant affected by the environment, e.g. the fact whether the consonant comes in a medial or final position in a word?
3. Is the duration of geminate consonants conditioned by the phonetic property of the respective consonants?

Hypothesis

Based on the previous studies and the phonetic property of sounds, it is hypothesized that

1. Amharic geminate consonants are not twice as long as their nongeminate counterparts.
2. Amharic consonants have a longer duration when they occur word finally rather than word medially.
3. Gemination in Amharic is conditioned by the phonetic property of the sounds. Thus, geminate continuants are expected to have a longer duration than geminate obstruents, and voiceless consonants are expected to have a longer duration than voiced consonants.

Methods

Participants

Three male consultants (speaking Amharic as their mother tongue) aged between 31 and 45 participated in the study. None of them had any history of disorder affecting normal articulation and perception of speech.

Data Collection

In order to investigate the duration of nongeminate and geminate consonants in Amharic, four word lists containing the consonants in identical environments were prepared. The word lists contain

- a. words that have word medial nongeminate consonants
- b. words that have word medial geminate consonants
- c. words that have word final nongeminate consonants
- d. words that have word final geminate consonants

All words in the word lists were real Amharic words. The consonants in (a) and (b) were placed between the low central vowel [a] and those in group (c) and (d) were preceded by [a]. When it was not possible to find a word with [a], either of the higher central vowels [ɛ] or [ɜ] was used. A total of 21 consonants (cf. appendix) were selected based on the frequency they have in appearing in analogous environment in both nongeminate and geminate forms. The consonants which were not included in the study, i.e. the labialized phonemes /k^w/, /k^ʷ/, /g^w/³, the bilabial

³ There are several labialized consonants in Amharic such as [t^w], [f^w], [ʃ^w] but they do not have phonemic status as they are the result of morphophonemic processes. For instance in the Amharic word [ab:at^wa] ‘her father’, the underlying form is [ab:at-u-a] ‘father-third person singular-third person feminine singular’. As two vowels do not come consecutively within a word in Amharic, {-u} gets deleted while the consonant retains the rounding feature by being labialized.

voiceless stop /p/ including its ejective counterpart /p'/⁴, and the palatal nasal [ɲ] are less frequent and could not be found in one, two or three contexts in which the duration of consonants was examined. The labial-velar approximant /w/ was not considered in the study because it was found to overlap with the preceding and following vowels and hence the measurement of the consonant's duration was affected, which in turn effected all the data.

Recording

Participants were recorded reading the word lists using a Sennheiser e-815 dynamic microphone attached to the CSL 4400 Kay audio capturing device connected to a computer at 44,100 Hz sample rate quantized at 16 bits in a relatively quiet room at the Akaki Campus of the Addis Ababa University. Each word was uttered three times by each of the consultants. All words were articulated in a similar intonation pattern to avoid any other influence (if there is any).

Measurement

A total of 756 tokens were measured with Praat version 5.1.23 by Boersma and Weenink (2010). The spectrogram and wave form of the words were used in identifying the segment boundaries in measuring the duration of the consonants under investigation. Then the mean of the measurements was computed for each of the various groups of sounds in word medial and final position.

Results and discussion

⁴ /p/ and /p'/ are not indigenous phonemes; they are found in borrowed words. /p/ is found in words borrowed from English such as /parti/ 'party' and /p'/ is found in few words words such as /p'ap':as'/ 'bishop', /t'ɜrɜp':eza/ 'chair'.

Table 1 summarizes the duration of the geminate and nongeminate consonants (randomly arranged) in word medial and word final position (only the first three digits were taken without approximation). All duration measurements are given in seconds except the ratios that do not need units of measurement.

Table 1: Mean duration of Amharic consonants in word medial and word final position.

Sound	MNGM	MGM	MNGF	MGF	MGM:MNGM	MGF:MNGF
R	24	111	147	262	4.625	1.782
B	55	173	163	303	3.145	1.858
L	57	148	145	205	2.596	1.413
N	58	126	154	273	2.172	1.772
D	63	137	179	294	2.174	1.642
J	64	100	168	241	1.562	1.434
M	78	130	195	312	1.666	1.6
G	84	129	193	285	1.535	1.476
ጃ	86	200	209	252	2.325	1.205
T	88	160	174	319	1.818	1.833
k'	89	143	156	293	1.606	1.878
t'	91	158	143	325	1.736	2.72
F	96	188	196	226	1.958	1.153
ጃ	97	158	217	320	1.628	1.474
ጥ	98	223	239	357	2.27	1.493
ገ	106	170	226	297	1.603	1.314
Z	106	157	178	276	1.481	1.55
S	107	165	207	309	1.542	1.492
ጥ	109	153	181	253	1.403	1.397
K	115	149	193	310	1.295	1.603
s'	116	206	155	258	1.775	1.664

As the results in Table 1 show, all geminate consonants were found to be longer than their nongeminate counterparts in similar environments. The discussion on the correlations between position, manner and voice are discussed in the following sections.

a. *Ratio of geminate to nongeminate consonants*

Amharic geminate consonants can be more than twice longer than their nongeminate counterparts when they appear in medial position (cf. Column 4 and Column 7 of Table 1). Seven of the 21 consonants under investigation, i.e. one third were twice or more longer when they were geminated in medial position. The alveolar trill /r/ stood out from the rest of the consonants as it became 4.625 times longer than the nongeminate /r/ in the same environment. In word final position, however, the geminate consonants were on average 1.607 times longer than their nongeminate counterparts. Eleven consonants, i.e. more than 50 % of the investigated consonants, were 1.5 or more times longer than their nongeminate counterparts when they appeared in word final position.

The ratio of geminate to nongeminate consonants has been investigated for voiceless and voiced consonants as two groups.

Fig.1 shows that voiced consonants had a greater ratio of GM:NGM and GF:NGF. The majority of the voiceless consonants showed a ratio between 1.29 and 2.5 whereas voiced consonants showed a ratio between 1.4 and 3.2. The median values, as it can be seen in the above box plot, show that the ratio of GM:NGM and GF:NGF of voiceless consonants was more than 1.5 whereas the ration for voiced consonants was more than 1.8. Considering mean values, the results show that voiced consonants had a greater increase in duration when they occurred as geminate word medially.

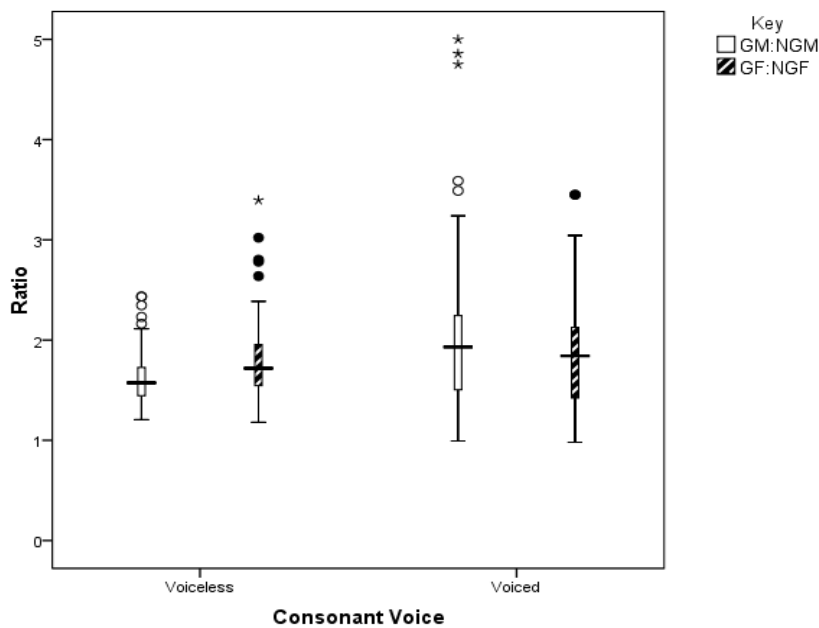


Fig.1: Box plot of ratio of geminate to nongeminate consonants by voice.^{5,6}

One-way ANOVA showed that the difference in the rate of increase in gemination (or ratio of geminate to nongeminate consonants) was significant due to voice_in medial position only, $f(1, 184)=24.3$, $p<0.001$.

Obstruents and sonorants were also compared. The results show that both word medially and word finally, the sonorants had a higher ratio of geminate to nongeminate duration. One-way ANOVA showed that the difference was significant

⁵ Note: For voiced consonants, the extreme values for GM:NGM (represented by asterisks) is the value for the consonant [r], which could be more than 4 times long when it appears as geminate consonant.

⁶ For any box plot hereafter, the bar indicates the median value, the length of the box indicates the interquartile range (IQR, which is the difference between the 25th and 75th percentiles), the symbol o indicates an outlier value that is between 1.5 and 3 times the IQR from the end of the box, and the asterisk indicates extreme values that are 3IQR from the end of the box.

$f(1, 184)=22.9$, $p<0.001$ in word medial position. This was expected as all the sonorants are voiced while a substantial amount of the obstruents are voiceless, and as discussed earlier, voiced consonants showed a higher ratio of the duration of geminates to nongeminates. The results are summarized in Table 2.

Table 2: Mean ratio of geminates to nongeminates for obstruents and sonorants.

Consonant Type	GM:NGM	GF:NGF
Obstruent	1.7177	1.7753
Sonorant	2.1755	1.9639

As far as the ratio of geminate to nongeminate consonants for different consonants having different manners is concerned, the ratio of the duration of geminate to nongeminate consonants word medially was higher for the trill /r/ > the liquid /l/ > the stops and affricates. Word finally, the ratio was higher for the trill /r/ > the nasals > the stops.

b. *Position vs. length*

In Amharic, position within a word was found to affect the length of consonants. All consonants investigated were longer in word final position than in word medial position both as nongeminate and geminate. The following line graph shows the mean duration of each sound investigated in the study.

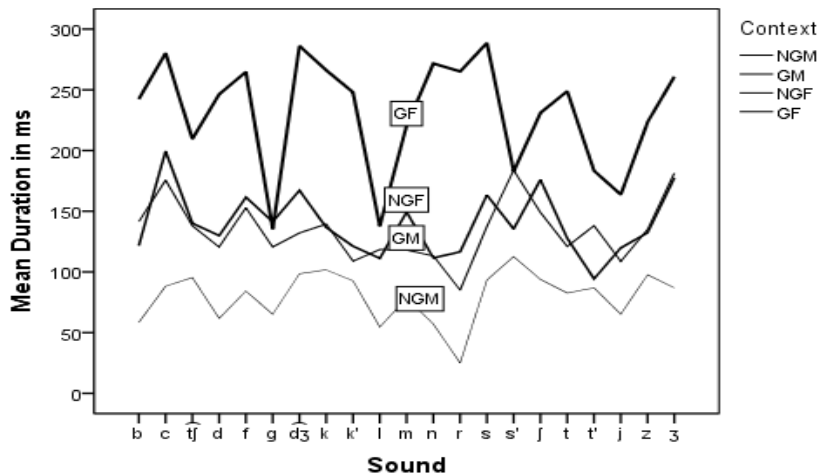


Fig. 2: Mean duration of Amharic consonants in word medial and final positions.

The difference in duration of consonants when they appear in word medial and final position was quite significant, $f(1, 750)=319.2$, $p<0.001$. It ranged from 1.29 to 3 for most of the consonants as can be seen in Table 2.

As can be seen from Table 1, [t'] and [s'] seemed to have been affected less by position while [r] shows a greater ratio of GM:NGM because it had a very short duration as nongeminate (24 ms) but a quite long duration as geminate (111 ms) in medial position.

c. Length vs. phonetic property

A strong correlation has been found between voicing and length. As presented in Fig. 3, voiceless consonants were longer than voiced consonants when they appear as geminate or nongeminate in word medial and word final position. The effect of voice on consonant length was stronger in medial position than in final position: $NGM-f(1, 186)=71.3$, $p<0.001$; $GM-f(1, 186)=17.6$, $p<0.001$; $NGF-f(1, 186) = 4.1$, $p<0.005$. There was no significant difference in duration between voiced and voiceless geminate consonants.

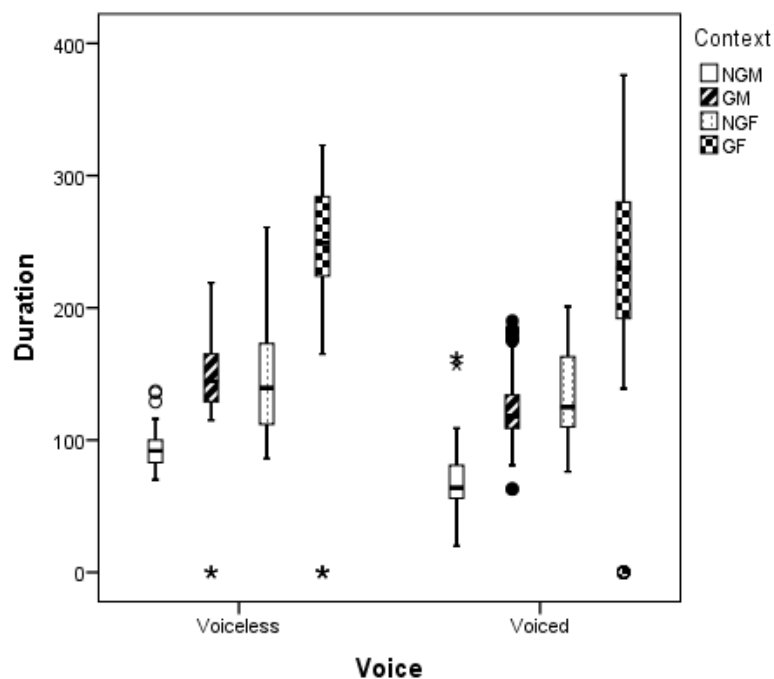


Fig. 3: Box plot of mean duration of geminate and nongeminate consonants by voice.

Fig. 4 shows that voiceless obstruents had longer duration than other types of consonants when non geminate consonants appear in intervocalic position. Except /k/, all voiceless stops had shorter duration than voiceless fricatives. They also had shorter duration than the voiceless and voiced affricates.

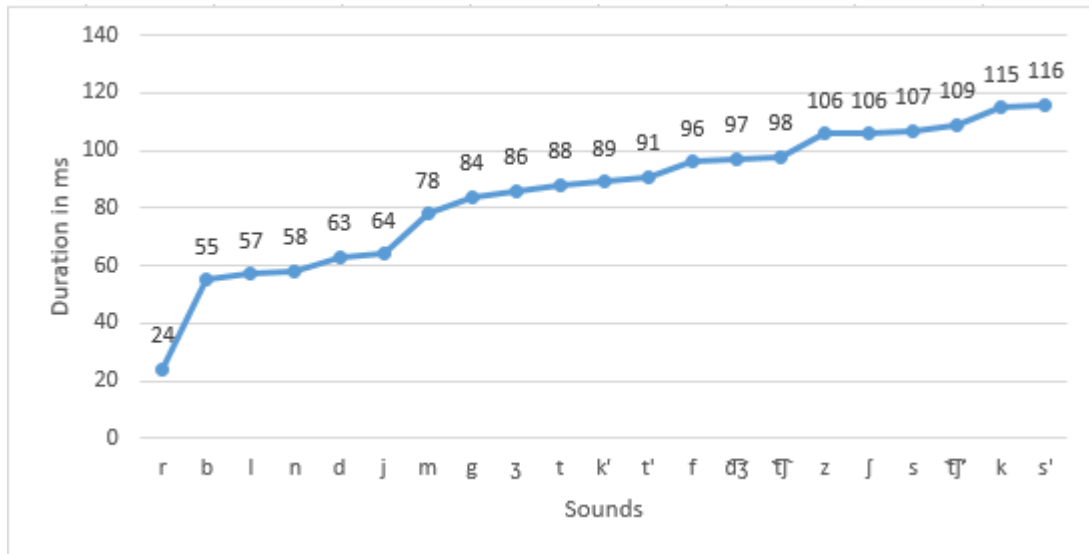


Fig. 4: Mean duration of Amharic sounds in intervocalic position.

When nongeminate, alveolar sounds in Amharic had a pattern fricative > stop and ejective > pulmonic but velars, which lack the fricative series in Amharic, had the pattern pulmonic > ejective. The alveopalatal affricates also had the pattern ejective > pulmonic.

When geminates are in word medial position, the only pattern that the duration of Amharic consonants can tell is that except /k/, all obstruents had longer duration than sonorants, as we can see in Fig. 5.

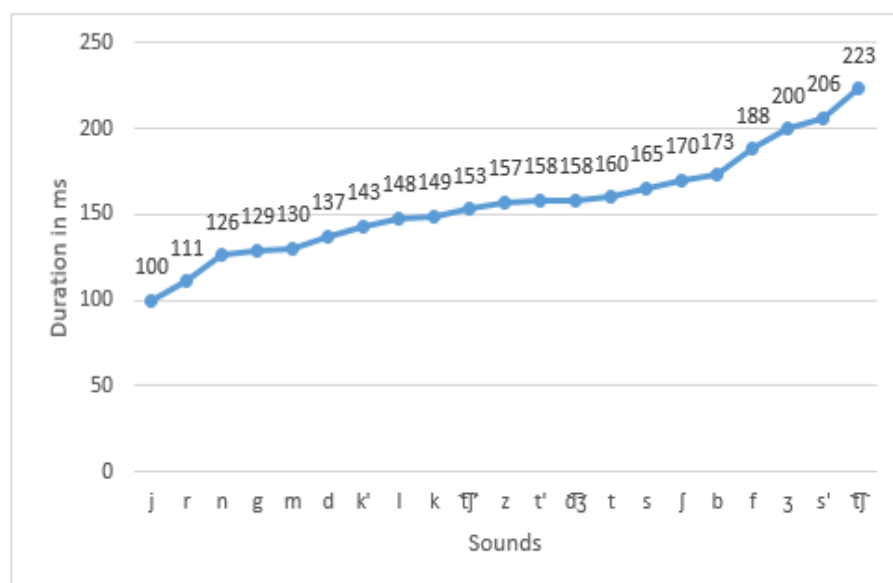


Fig. 5: Mean duration of geminate Amharic consonants in intervocalic position.

Looking at the average length of consonants with different manners, nongeminate fricatives were longer than nongeminate affricates, which were in turn longer than nongeminate stops in word medial position. When geminate, however, fricatives were longer when they occurred in medial position while stops were longer when they occurred in final position. Fricatives and the liquid [l] showed a very striking similarity in that they had relatively the same duration when they occurred nongeminate in word final and geminate in word initial position.

A one-way ANOVA of duration as a dependent variable and manner as a fixed factor showed significant differences between stops, fricatives, affricates and sonorants: $f(3, 182)=39.8$ ($p<0.001$) for GM; $f(3, 185)=42.17$ ($p<0.001$) for NGM and $f(3, 185)=21.93$ ($p<0.001$) for NGF. A further post-hoc analysis using Scheffe post-hoc test showed that the significant differences in duration were:

- (a) for GM between sonorants and nonsonorants and between stops and fricatives at $p < 0.001$, and
- (b) for NGM between sonorants and nonsonorants and between stops and fricatives $p < 0.001$, between stops and affricates at $p = 0.005$

Conclusions

Based on the results found, we can reach the following conclusions:

Geminate consonants can be twice as long or more as their nongeminate counterparts. The average rate of gemination in medial position is close to 2. In word final position, however, the average rate of gemination is 1.6. The study confirms Ladefoged, Maddieson's (1996) claim that geminate stops are 1.5 to 3 times longer than their nongeminate counterparts. The average length of geminate stops in Amharic was found to be 1.901 in word medial position and 1.862 in word final position.

There was a strong correlation between the nature of the consonant and length in Amharic.

- a. Voiceless consonants were longer than voiced consonants when they occurred as nongeminate in word medial position irrespective of place of articulation. When geminate, voiceless consonants were longer than voiced consonants at the same place of articulation, except the alveopalatal affricates which showed the opposite pattern.
- b. Fricatives were longer than affricates and stops when they occurred as nongeminate in word medial position.
- c. Sonorants were shorter than obstruents when they occurred as geminate or nongeminate in word medial position.

There was a strong correlation between position and duration. Consonants were longer word finally than word medially irrespective of whether they were geminate

or nongeminate. There was also a strong correlation between position and the ratio of geminate to nongeminate consonants. The rate of gemination was higher in word medial position than in word final position.

There was also an interplay between position and phonetic property of consonants with regard to the rate of gemination: voiced consonants showed a greater increase in length when they occurred as geminate in word medial position.

Abbreviations

IQR	inter quartile range
MGF	mean duration of geminate consonant in word final position
MGM	mean duration of geminate consonant in word medial position
MNGF	mean duration of nongeminate consonant in word final position
MNGM	mean duration of nongeminate consonant in word medial position
GF / NGF	the ratio of geminate consonants in word final position to non-geminate consonants in word final position
GM / NGM	the ratio of geminate consonants in word medial position to non-geminate consonants in word medial position

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Appendix: list of words used in the elicitation

All words are transcribed phonemically. The seven vowels of Amharic are represented by the following IPA symbols: /ɜ/, /u/, /i/, /a/, /e/, /ə/ and /o/. Gemination is marked by/:/

	Position: Nongeminate medial	Gloss
1	Abal	member
2	Adal	place name in North Shoa where Afar people live
3	Akal	body
4	agasɜs	horse (derogatory)
5	ak'ak'i	a suburb of Addis Ababa
6	at'ana	log (of wood)
7	Atamo	drum
8	atʃ'af	someone who smokes
9	tʃatʃata	noise (of people)
10	arat:	four

11	alak'i	consumable
12	Asar	suffering
13	aʃara	finger print
14	adʒəb	convoy (escort)
15	azap	someone who sympathizes with others
16	Amat	father or mother in law
17	Anat	central part of the head
18	məʒjaz	to hold
19	nəs'a	free
20	aʒara	gravel
21	afaf	someone who collects things such as grain from the ground

Position: Medial gemination**Gloss**

1	ab:at	father
2	ad:araʃ	hall
3	ak:ababi	environment
4	ag:afari	someone in charge of welcoming and showing places to guests in the palace
5	ak':at'ari	someone who tells what one has said to another person
6	at':ari	investigator
7	at:alaj	deceiver
8	atʃ:fari	someone who joins a person or a group in a dance
9	atʃ:a	equal, counterpart
10	ar:ami	someone who weeds or corrects
11	al:ami	someone who aims
12	as:adadʒ	someone who chases
13	aʃ:ami	doubtful
14	adʒ:abi	escort (n)
15	az:aʒ	commander
16	am:akari	advisor
17	an:adadʒ	someone who annoys
18	aj:ajaʒ	something that is used to fix broken parts
19	nəs':a	become white, become free from evil and sin
20	aʒ:ʒ	leaked
21	af:ap	oppressor, hijacker

	Position: Nongeminate final	Gloss
1	kab	stone wall
2	ləmad	culture, custom
3	əkək	itch
4	bɜg	sheep
5	sak'	laugh (noun)
6	tɜnafɜt'	Clean your nose!
7	fəkət	brightness
8	lɜhatʃ'	saliva
9	takatʃ'	someone who gets tired or bored
10	adar	night
11	akal	body
12	nɜfas	wind
13	araʃ'	farmer
14	aradʃ'	butcher
15	mɜzɜz	consequence
16	lam	cow
17	zɜfɜn	music, song
18	bɜlaj	on top
19	k'əs'	form
20	az:ɑz	commander
21	af	mouth
	Geminate final	Gloss
1	ləb:	heart
2	səd:	naughty
3	lək:	measure, equal, right
4	fət:əg:	to rub
5	lək':	free
6	sək't'ət':	a feeling one has when he/she hears a squeaky noise
7	kət:	something (clothes, jewellery) worn during special occasions
8	ləmtʃ'ətʃ':	to shrink
9	kətʃ:	become surprised
10	kər:	thread

11	dəl:	quite big (for a party or wedding)
12	kəs:	charge
13	kəʃ:	a sound of breaking
14	ədʒ:	hand
15	fəz:	dump
16	dəm:	the noise that one makes when walking on ground
17	bən:	scattered
18	bəj:	a small circular glass ball used by children in a game
19	k'ərə:s':	to shape
20	bəʒ:	becomes difficult to see
21	laf:	to take something quickly