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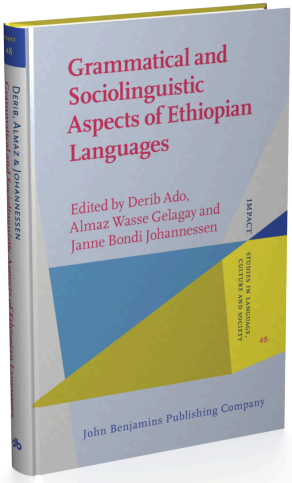

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Durational variations in Oromo vowels

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An acoustic study of vowels of Cushitic languages has not been undertaken, though their vowels seem to exhibit durational variations. We wanted to identify factors that would affect vowel length in Oromo, a Cushitic language widely spoken in the Horn of Africa. Sixty-four speakers (F = 32, M = 32) from four dialect areas of the language in Ethiopia produced vowel data in different environments. An acoustic analysis of the data showed that duration of the vowels varies significantly across dialects, with the longest duration in the Eastern dialect and the shortest duration in the Western dialect. Gender has no significant effect on duration of the vowels, but the vowels have significantly longer duration when followed by voiced singletons than voiceless, and when followed by voiced singletons than by voiced geminates. Collectively, phonologically long vowels are two times longer than short ones, and this difference is significantly affected by dialect and environment, but not by gender. A significant variation was also observed among the vowels with regard to their intrinsic duration. It is concluded that, besides phonological length, the regional background of speakers and phonetic environment are key factors determining duration of Oromo vowels.

Keywords: Oromo, vowel, dialect, duration, environment, Cushitic

1. Introduction

We undertake an acoustic study of Oromo vowels to identify factors that will cause a durational variation in the sounds. Oromo is one of the Cushitic languages that has five vowels with a contrastive length. The language is spoken over a wide geographic area in the Horn of Africa and, consequently, we suspect that we will find not only durational variation due to phonological length, but also due to sociolinguistic factors. We also suspect that duration of the vowels could vary as a function of consonantal environments, as previous studies have reported durational variation of vowels in these environments.

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In addition to a qualitative variation, a qualitative variation has been attested in the vowels of different languages (Gordon 2016). Japanese and Arabic are examples of those languages that have short and long vowels and that productively use them to make a pair of contrastive words. Two Arabic verbs which mean 'to leave' and 'to swear' are distinguished based on vowel length: the former contains the short /i/while the latter the long /i:/. Japanese speakers would say the same word twice if they did not use the short /i/ and the long /i:/ to say the words 'listened' and 'came', respectively. Similarly, in Cushitic, Nilo-Saharan and Eastern Omotic languages, length is phonemic, producing a pair of short and long vowels (Bender, Mulugeta, & Stinson 1976). Nilo-Saharan languages such as Dink, Shilluk and Nuer are characterised by a three-way length contrasts in their vowels (Wedekind 1989). Such a contrast is not common in world languages and the contrast is arguably prosodically and/or morphologically determined (Gordon and Peter, 2001; Lippus, Asu, Teras, & Tuisk 2013).

Vowels have intrinsic duration, in which open vowels are longer than close vowels as a general phonetic tendency attested to in several languages (Holt, Jacewicz, & Fox 2015). This difference is attributed to the fact that the tongue and the jaw should move a longer distance toward the target for an open vowel than for a close vowel (Catford 1977). However, this durational difference is not observed in the acoustic study of vowels of Standard Austrian German, Modern Standard Albanian, and Creek (Johnson & Martin 2001). A large durational value has been reported for a phonologically long vowel because the time required to produce it is nearly twice that of its counterpart in languages such as Japanese, Thai, Arabic, Norwegian and Swiss French (Hirata 2004; Kukkonen 1990; Tsukada 2009; Dommergues 2007; Behne, Moxness, & Nyland 1996). It seems that a durational difference between short and long vowels of these languages is generally predictable, but the ratio of long to short vowels in different contexts can be language-specific (Purnell et al. 2005).

The variation of vowel duration by gender is well-studied, but contradicting results are often reported. Hillenbrand et al. (1995) demonstrated a significant difference between vowel duration in women and men, with men producing a shorter vowel. Similarly, an acoustic study of vowels produced by speakers of African American English and White American English showed that women have a longer vowel than men irrespective of their social background (Holt, Jacewicz, & Fox 2015). It is also known that Swedish female speakers tend to use longer vowels than male speakers (Ericsdotter & Ericsson 2001). A similar finding was reported in a study on two Portuguese dialects in which women produced longer vowels than men (Escudero et al. 2008). Such an effect of gender was not found in acoustic studies of American English (Clopper, Pisoni, & de Jong, 2005; Jacewicz, Fox, & Salmons 2007) and British English (Williams & Escudero 2014). Clearly, the

findings of past studies on the effect of gender are not conclusive, and thus more study is needed to investigate the effect of gender.

The other insight obtained from past acoustic studies is that speakers of different dialects may produce vowels with different duration. In this regard, more data seem to be available on the vowels of the English language (Williams & Escudero 2014). Clopper, Pisoni, and de Jong (2005) found a significant main effect of dialect in the acoustic study of six American English dialects, with the Southern speakers generally having significantly longer vowels than speakers from the New England, the Mid-Atlantic, and the West. They also indicated a significant dialect and vowel category interaction in vowel duration. Another study on three American English dialects (Mid-Atlantic, Southern and Midland) revealed that Midland speakers produced the longest vowel duration in all vowel groups, but the Mid-Atlantic and Southern speakers did not differ in mean duration (Oder, Clopper, & Ferguson, 2013). A similar finding was reported in a study on two Portuguese dialects in which the European Portuguese produced longer vowels than the Brazilian Portuguese (Escudero, Boersma, Rauber, & Bion 2008). Speakers of Welsh dialects also significantly differ in duration of their vowels (Mayr & Davies 2011). Apparently, speakers of different dialects seem to develop some articulatory timing for their vowels, which serves as a sociolinguistic identifier.

Phonetic environments such as consonantal and suprasegmental environments can also influence vowel duration. In this regard, the most common finding is the effect of the voicing characteristics of the following consonants. Vowels become longer before voiced consonants than before voiceless consonants in English, Dutch, Japanese and several other world languages (Begus 2017; Luce & Charles-Luce 1985). Vowel duration is significantly influenced by consonantal length in languages where consonantal length is contrastive. Vowel duration is shorter when followed by geminate than by singleton in German and Italian. However, in languages such as Japanese, the opposite pattern exists: vowels become longer when they precede a voiced or a voiceless geminate (Idemaru & Guion 2008). In addition, a vowel in an open syllable and a stressed syllable is longer than one in a closed syllable and an unstressed syllable, for instance in Scottish, English and Italian (McClure 1977; de Jong 2004; Hajek & Stevens 2008). A suprasegmental context is also known to influence vowel duration. A vowel with a high rising tone is longer than one with a falling tone, and a vowel with low level tone is longer than one with a high-level tone (Kong 1987; Wayland 1997). In pitch-accent languages, acoustic studies yielded inconclusive results regarding the effect of pitch on vowel duration. For instance, Hoequist (1983) found a significant effect of pitch on vowel duration, but other researchers could not find such an effect on vowel duration (Beckman 1982; Homma 1981).

2. Oromo language

Oromo is one of the Cushitic languages spoken in Ethiopia and Kenya (Blažek 2010; Stroomer 1995). The number of dialects of the language is not clearly known, as the number ranges between three and five in Oromo studies. The language is classified into three dialect areas in Heine (1981), into four dialect areas in Gragg (1976), and into five dialect areas in Bender, Mulugeta and Stinson (1976), Lloret (1988) and Kebede (2009). For instance, in Kebede (2009), the language is genetically classified into Western, Eastern, Northern, Central and Waata. Lack of reliability in determining the number of dialects can be attributed to the large area over which the language is spoken, as well as methods of classification (Blažek 2010; Feda 2015). No study has been conducted to investigate mutual intelligibility among the dialects. However, speakers of the language seem to understand one another with little loss of comprehension because, as Owens (1985) observed, their dialects are largely more silmilar than different. Consistent with this observation, Bender (1971) and Blažek (2010) reported significant overlap among Oromo dialects with respect to their basic vocabulary. The current study is based on Kebede (2009), because it is more comprehensive, including all dialects of the language, although speakers of the language in Kenya are not included (See 3.1 below).

Table 1. The five basic vowels of Oromo (Lloret 1988)

	Front	Central	Back
Close	i		u
Mid	e		o
Open		a	

Oromo, like many other Cushitic languages, has five distinct vowels (Table 1), which contrast in length (Owens 1985; Lloret 1988). Many minimal pairs can be found in the language, and one such pair is /ra:fu:/ 'cabbage' vs. rafu: 'to sleep', or /du:te/ 'died' vs dute, 'barked'. In the literature, vowel length is interpreted as an extension of articulation timing of a single phonemic unit (Behne, Moxness, & Nyland 1996), or as a linear concatenation of two identical vowels. The interpretations seem to be based on different theories of phonology. According to one of the theories, long vowels in Oromo are interpreted as a single unit, not as a sequence of two identical short vowels (Lloret 1988).

Oromo also distinguishes consonant phonemes based on length (Dissassa 1980; Owens 1985) but the phonemes, /h/ and /ʔ/ are not geminated. Geminated consonants do not occur in a word-initial position in the language. In many languages, geminated consonants tend to be two or more times longer than short ones, and

this difference varies as a function of consonant type, phonetic environment and emphasis (Payne 2005; Kawahara & Braver 2014). On the whole, nasals and stops are known to have the biggest difference while fricative and affricate have the least difference (Aoyama & Reid, 2006). Apart from qualitative data, no published acoustic data are available on the duration of Oromo consonants. As discussed above, a consonantal length can affect the duration of the preceding vowel, and we want to determine if this holds true for Oromo.

The studies reviewed above suggest that there are different factors that will affect duration of vowels, and such factors evidently may have effects on duration of Oromo vowels, as well. Previous studies on the language have focused on the qualitative description of its vowels (Owens 1985; Lloret 1988; Stroomer 1995). To the best of our knowledge, no acoustic study has been conducted to investigate to what extent such factors influence vowel duration in the language. Therefore, we want to examine the intrinsic duration and durational correlates of phonemic length of vowels of the language. In addition, we want to investigate to what extent gender, dialect and consonantal contexts influence duration of vowels of the language. This study can contribute to the production of acoustic data for language teaching, speech therapy and speech technology.

3. Methods

3.1 Speakers

Oromo varieties spoken in Kenya were not included for a security reason. Speakers from the Raya variety of Oromo were also excluded from the study, as the variety is shifting to neighboring Semitic languages (Kebede 2009). Using a simple random sampling, Macha from the Western dialect, Arsi Highland from the Eastern dialect, Arsi Lowland from the Central dialect and Wollo from the Northern dialect were selected. Ayira, Jarra, Karsa and Bati are small which were chosen to collect vowel data from the speakers of Macha, Arsi Highland, Arsi Lowland and Wollo, respectively. These areas were purposively sampled in order to find speakers who do not much have much contact with other dialects and languages. Sixty-four native speakers (16 speakers for each town) who were willing to participate in the study were selected. The number of female and male speakers was balanced (across dialects) to examine the effect of gender on vowel duration. The speakers have lived all their lives in their respective areas, though they might have been exposed to other dialects via mass media and formal education. The range, average and standard deviation of age of the speakers were 7 years, 25 years and 2.6 respectively.

3.2 Stimuli and procedures

The participants were presented with ten (five short and five long) vowels embedded in real words in isolation (Table 2). They were instructed to produce the words five times (using their normal rate of speech) while being recorded. The real words were a list of words containing short and long vowels between three stop consonants (/d/, /k/, and /t/) and the geminate /d:/. The consonants were used for their clear closure of air, which allows for a distinctive identification of boundaries of the vowels. In addition, the sounds were used to manipulate the voicing characteristics and duration of the following consonants, because the study aimed at investigating the effects of these two features on the duration of vowels. The words have two to three open syllables (See Wako 1981 for Oromo syllabic structures), but the duration data were extracted from the first or the second syllable (Table 2). In the selection of the words, accent was not considered, because there are contradicting views as to whether the language has a tone system, or a pitch-accent system (Heine 1981; Wako 1981; Owens 1985; Lloret 1988).

Table 2. List of Oromo vowels in different phonetic environments for duration measurement

Vowel	Before a voiced singleton, /d/		Before voiceless singletons, / k, t /		Before a voiced geminate, /d:/	
	Word	**Gloss**	**Word**	**Gloss**	**Word**	**Gloss**
/a/	/dadar/	Name of a town	/kaku:/	Covenant	/bad:a:/	Highland
/i/	/dide/	He refused	/titisa/	Fly	/ʔabid:a/	Fire
/e/	/hededa/	Edge	/buteka:/	Here, he snatched…	/ded:e:bi:/	Returning repeatedly
/o/	/dodola/	Name of a town	/ta:tota/	Actors	/bod:ose:/	Attractive
/u/	/dudu ʔa:/	Dead	/kuta:/	Class	/dud:a/	Back of a body
/a:/	/ada:da:/	Aunt	/ʔaka:ku:/	Type	/barba:d:e/	She searched.
/i:/	/di:da/	Outside	/gati:ti:/	Throw away and …	/di:d:e/	She destroyed.
/e:/	/ge:do:/	Name of a town	/ʔate:te:/	Religious ritual	/de:d:e/	She became poor.
/o:/	/gado:de/	He screamed	/hat:o:ta/	Thieves	/bo:d:e:/	At the back
/u:/	/du:da:/	Deaf	/tu:ta/	Group	/du:d:a:/	Become deaf!

The words were recorded in an open quiet space using Maritz Professional (Solid State Recorder MPD 661MKll) equipped with a Sennheiser 865 condenser microphone. The words were written in Oromo orthography so that speakers could read them by identifying the short and long sounds. Before the actual recording, the

speakers were familiarised with the words on the list. The recording yielded (3 repetitions x 10 vowels x 64 speakers x 3 environments) 5,760 tokens. The tokens were pre-amplified, low-pass filtered at 4.3 kHz, and directly digitised at 16-kHz sample rates and quantised at 16 bits.

The duration of each vowel was measured from the first positive peak in the digitised waveform up to the portion of acoustic silence that signals the constriction of the postvocalic stop. Vowel onset and offset were manually located in PRAAT (Boersma & Weenink 2013) in textgrids based on the waveform and the spectrogram. The onset and offset locations in the textgrids served as input to PRAAT script, which automatically extracted the duration of each vowel in each token. The script was written by (Lennes 2017) and can be found at <http://www.helsinki.fi/~lennes/praat-scripts/>. The Cronbach's Alpha showed that the internal consistency for vowel duration was 0.917, which indicates that the reliability of the duration measurement was very good.

3.3 Statistical analysis

From the five repetitions of the words, the first and the fifth were excluded (rendering three tokens per speaker) to avoid the impact of beginning and ending effects of speech on duration of vowels. The vowel duration was normalised by converting the raw data into z-scores (Wang & Chen 2012). Normalization was needed to reduce vowel durational variances due to articulation rates, positions of vowels in words, and length of words in which the vowels were embedded. A normalised duration value of zero shows duration equivalent to overall mean duration across all vowels. A normalised duration below zero indicates duration shorter than overall mean and a normalised duration above zero indicates longer than the mean duration.

4. Results

4.1 Intrinsic duration

The intrinsic vowel duration was only computed for the five short vowels, as they are considered basic vowels for the language, but it was averaged across dialects and gender in the contexts of singleton and voiceless stops. There was a statistically significant difference among the basic vowels with respect to their intrinsic duration [$F(4, 56) = 27.94, p < 0.001$]. The vowels are clearly differentiated, but the difference between the open and close vowels is more pronounced (Figure 2). As reported for many languages, in Oromo the open vowel /a/ (80 ms) had the highest mean duration while the close vowel /u/ (63.44 ms) had the lowest mean duration,

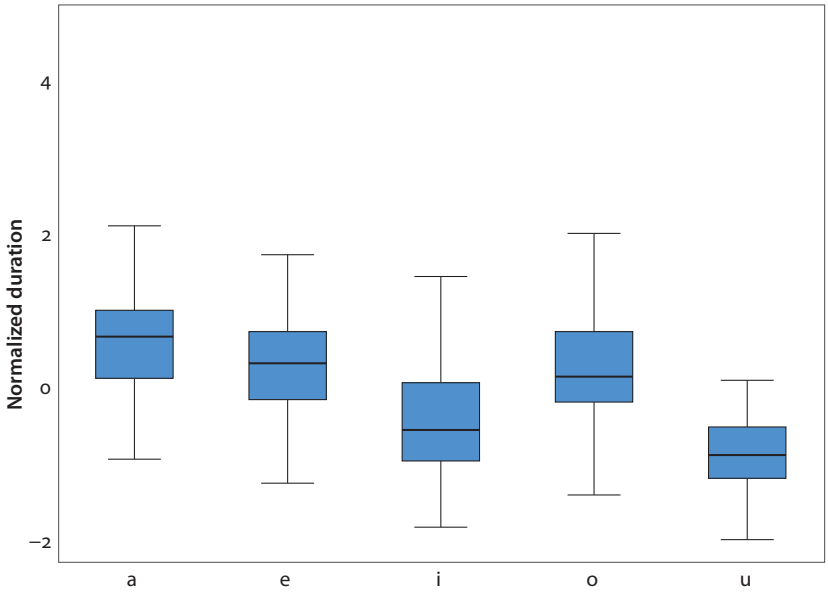

Figure 1. Mean values of normalised intrinsic duration of the five basic vowels

as compared to others. The ratio of an open vowel to a close vowel is 1.26, which suggests that the open vowel is about 1.3 times longer than the close one, and this relative length should be a language-specific acoustic feature.

A significant interaction was not found for intrinsic vowel duration x gender [F (4, 56) = 0.86, p = 0.48], vowel duration x dialect [F (13, 56) = 1.71, p = 0.06] and vowel duration x gender x dialect [F (12, 56) = 0.66, p = 0.78]. This suggests that intrinsic vowel duration seems to be preserved and does not vary with dialect and gender, and thus regardless of their gender and dialectal background, speakers of the language seem to produce open and close vowels with a similar durational difference.

4.2 Phonological vowel length

Of central interest to us is the investigation of a durational correlate of phonological vowel length in Oromo, and durational difference between the long and short vowels is clear, as indicated in Figure 3. The mean durations for the short and long vowels were 74.34 ms and 156.54 ms respectively, showing a big durational contrast between the two groups. This difference is significant [F (1, 56) = 1330, $p < 0.001$], with long vowels, on average, twice longer than short vowels. The result indicates that speakers of a language with phonologically short and long vowels may need a large durational difference to produce a phonemic contrast, which helps to distinguish the corresponding sounds.

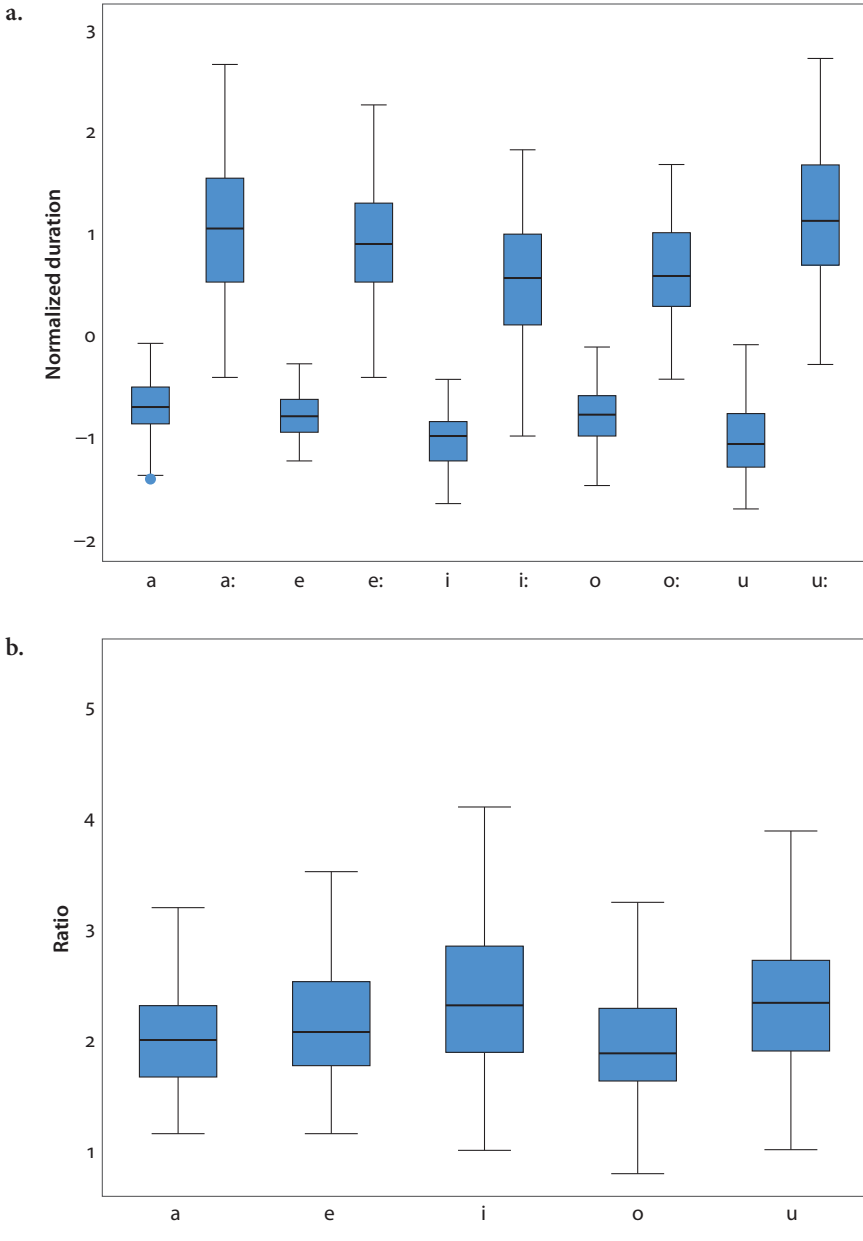

Figure 2. Mean values of normalised duration of short and long vowels, and their ratios

A significant interaction was found for phonological vowel length and dialect, [F (3, 56) = 7.93, $p < 0.001$] but the interactions of phonological length and gender [F (12, 56) = 0.66, $p = 0.78$] and phonological length, gender and dialect [F (12, 56) = 0.66, $p = 0.78$] were not significant. This suggests that the durational contrast between short and long vowels does not significantly vary with gender but differs based on only the dialectal background of speakers. The Central (80.6 ms) and Eastern (176.49 ms) dialects had the greatest mean duration, while the Western (66 ms) and the Wollo (139.57 ms) dialects had the lowest mean duration for short and long vowels, respectively. Another interesting finding is that significant interaction of phonological length with the voicing characteristics of the following consonants (stops in this case) was observed, [F (1, 56) = 37.87, $p < 0.001$]. The mean values of short vowels before voiceless and voiced stops are 68.33 ms and 76.87 ms, respectively, and thus the variance in the duration of short vowels seems to greatly contribute to such a significant interaction. The contextual difference for the long vowels is small; the mean values are 159.51 ms and 160.42 ms when the sounds are produced before voiceless and voiced stops.

The mean ratio of duration of short to long vowels was computed to see if vowel category, consonantal environment, dialect, and gender affect it. The vowel open /a/, has the lowest mean ratio (2.034) while the close vowel /i/, the highest mean ratio (2.412), which suggests that the ratio is inversely related to a vowel height. The statistical analysis shows that the mean ratios significantly vary with a vowel category [F (4, 56) = 14.36, $p < 0.00$], and with dialect [F (3, 56) = 7.61, $p < 0.001$] but not with voicing status of the following stop [F (1, 56) = 1.79, $p = 0.19$] and with gender [F (1, 56) = 3.16, $p = 0.081$]. Post hoc analysis using Bonferroni shows that, with the exception of the Western and Central dialects and the Eastern and Northern dialects, the other pairs compared differ in their mean ratios of short to long vowels, [F (1, 56) = 1.79, $p = 0.19$], indicating that speakers of different dialects of the language do not use similar durational contrasts to differentiate between short and long vowels.

4.3 Consonantal environments

In this study (See Table 2), consonantal environments include voicing characteristics (voiced vs voiceless in the contexts of /d/ vs/ t, k/) and length (geminate vs singleton in the context of /d/ vs /d:/) of the following stop consonants.

Vowels preceding voiced and singleton consonants were significantly longer than those before voiceless (F (1, 56) = 20.7, $p < 0.001$) and geminated consonants (F (1, 56) = 18.55, $p < 0.001$). The mean duration of vowels before voiced and voiceless consonants (in this case stop) were 76.22 ms and 68.32 ms respectively, while the mean duration of vowels before geminate and singleton were 72.44 ms and

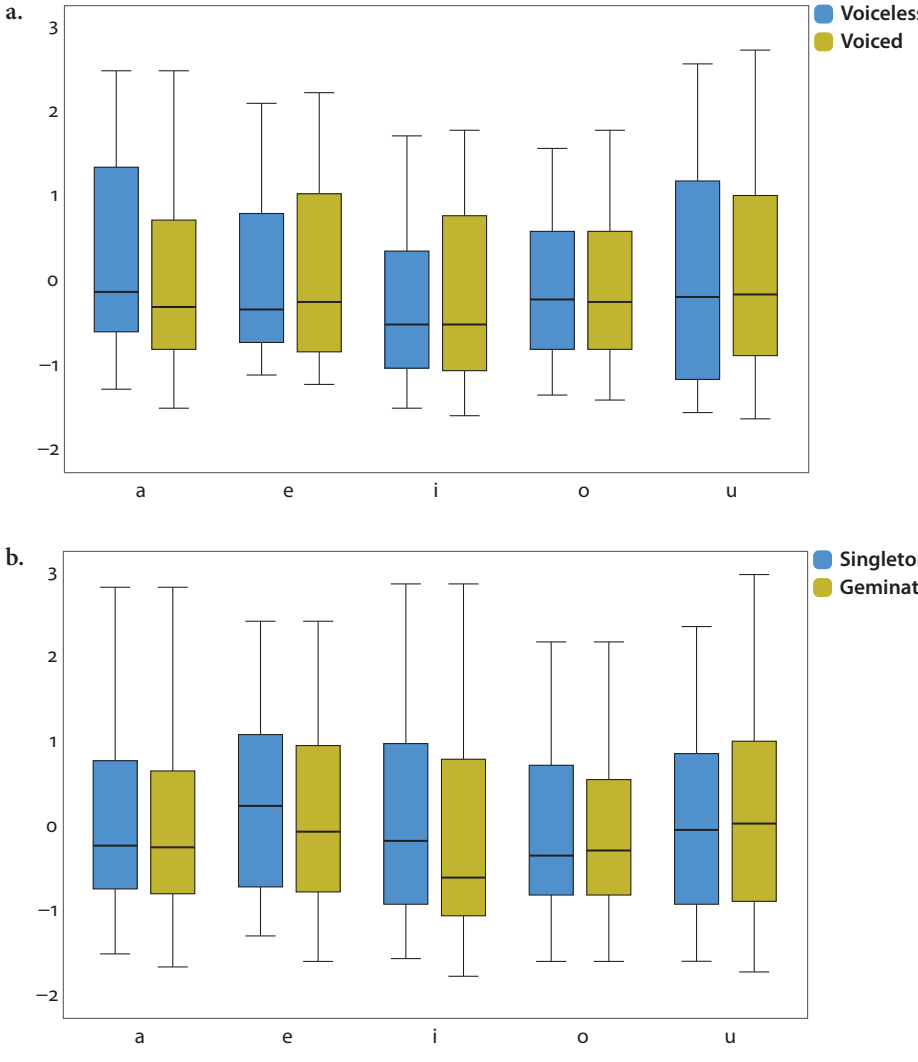

Figure 3. Mean values of duration of vowels preceding geminate vs singleton and voiced vs voiceless singletons

76.21 ms, respectively. The anticipatory lengthening of a vowel preceding voiced consonant was confirmed once more in the present study. There was also a significant interaction of consonantal length and vowel category (F (4, 53) = 26.35, $p < 0.001$). The significant interaction between consonantal length and vowel category arose from the fact that the mean difference produced by consonantal length was greater for the vowel /u/ in a geminate environment and for the vowel /e/ in a singleton environment than for any other.

4.4 Gender

Gender is one of the between-subject factors and, based on research which reported a significant effect of the factor, we expected that gender would influence vowel duration in Oromo, but the effect of gender on vowel duration was not significant (F (1, 56) = 0.19, p = 0.66). The mean duration for female and male were 73.86 ms and 70.76 ms, respectively, and their difference was too small to reach a statistical significance, which suggests that speakers of the language may not differentiate gender based on duration of vowels. The interaction of gender and dialect is not significant, (F (3, 56) = 1.49, p = 0.34), implying that vowel duration in the language does not vary as a function of gender across dialects.

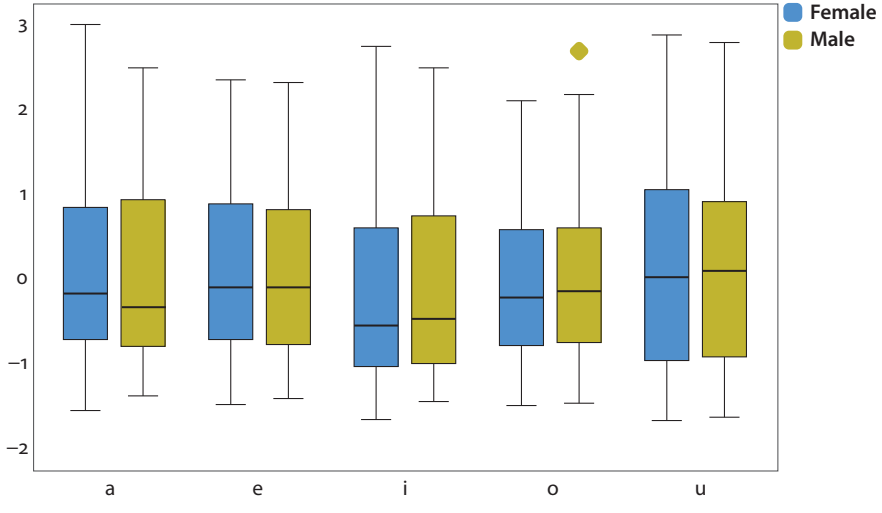

Figure 4. Mean values of normalised duration of vowels produced by female and male speakers

4.5 Dialect

Finally, an acoustic analysis of the data showed that duration of the vowels varies significantly across dialects, with the longest duration in the Eastern dialect (76 ms), and the shortest duration in the Western dialect (66 ms), (F (3, 56) = 8.78, $p < 0.001$). Post-hoc analysis of pair wise group comparisons using Bonferroni indicated that mean differences between Eastern (M = 169.67 ms, SE = 4.83 ms) and Western dialects (M = 18.89 ms, SE = 4.38 ms), Eastern and Northern (M = 22.15 ms, SE = 4.83 ms), and Central and Northern (M = 13.67 ms. SE = 4.83 ms) dialects

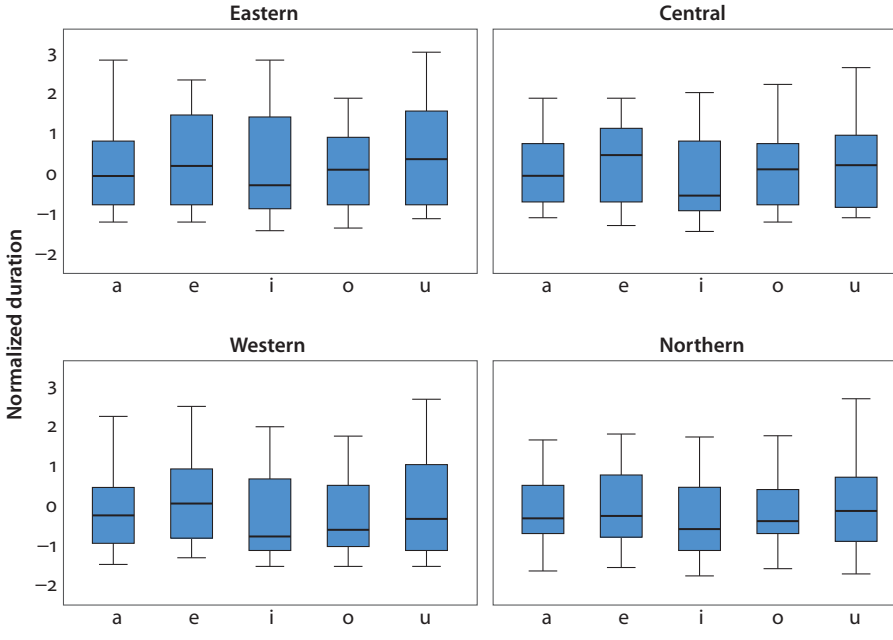

Figure 5. Mean values of normalised duration of vowels produced by talkers from different dialects

were significant, $p < 0.01$. The result reveals that dialect is an important sociolinguistic factor affecting vowel duration in Oromo and, conversely, duration of vowels is an acoustic indicator of a dialectal variation in the language.

5. Discussion

In this study of durational variation in Oromo vowels, we examined various factors that might cause durational differences in the sounds. Consistent with Hillenbrand, Getty et al. (1995), we found that Oromo vowels differ significantly in terms of their absolute duration. The phonemes /u/ and /a/ had the lowest and highest mean durations, and this difference is attributed to the way they are articulated. The opening of the lower jaw requires longer time for the open vowel /a/ than for the close vowel /u/ (Hertricha & Ackermann 1997). The phonetic general tendency that intrinsic vowel duration is inversely related to vowel height is also confirmed in the current study. In addition, phonological length led to a large durational difference between short vowels and their long counterparts. On average, the long vowels are two times longer than their corresponding short vowels, and similar findings were

reported for German by Braunschweiler (1997), and for Malayam by Velayudhan and Howie (1974). Oromo vowels significantly differ in their mean duration ratio of short vowel to long vowel. Duration provides a robust perceptual cue for differentiating long and short vowels, and thus the large durational difference should not be not surprising (Hillenbrand, Clark, & Houde 2000; Rosner & Pickering 1995).

There is a general tendency in the world's languages for a vowel preceding a voiced stop to lengthen. This tendency holds true for Oromo, as its vowels have significantly longer duration before a voiced stop than a voiceless stop, in agreement with previous studies (Braunschweiler 1997). The durational difference due to a voicing characteristic of the following consonant is attributed mainly to a motor control of articulators. An anticipatory use of greater articulatory energy for a voiceless stop, greater intraoral pressure during the articulation of a voiceless stop, a swift setting of focal folds for maintaining voicing and compensating for a reduced closure duration after a longer vowel are hypothesised to result in a longer vowel before voiced stops (Begus 2017). Similarly, Raphael (1975) examined activity of muscles of articulators using EMG, and observed that vowels preceding voiced consonants needed more muscular activity, which might mean longer articulation time.

One of the findings of the current study is that a vowel is shorter before a geminated stop than before a singleton stop. In some previous studies, a vowel preceding the geminate consonant was reported to be shorter (Esposito & di Benedetto 1999; Ridouane 2007; Aldubai 2015; Kaye 2005), while in others, an opposite result was found (Hansen 2004; Idemaru & Guion 2008; Tserdanelis & Arvaniti 2001). The contradicting results are attributed to language-specific rules for weight, stress patterns and syllable structure. For instance, the effect of consonant length is observed in only stressed syllables in Italian (Payne 2005). The articulatory system seems to compensate for the time required for producing a long consonant by decreasing the duration of the preceding vowel. In the current study, the target vowels were followed by the stop geminate /d:/ and its singleton counterpart. Geminates require a greater constriction of the vocal tract, which in turn requires longer time, and thus the duration of the preceding vowel is shortened in anticipation (Al-Tamimi & Khattab 2015). Apart from providing a perceptual cue for the following segment (Hillenbrand, Clark, & Houde 2000), a compensatory shortening of vowels may be used to facilitate articulation.

Past acoustic studies investigating the effect of gender on vowel duration have reported contradicting findings. In agreement with some of these studies (e.g., Most, Amir, & Tobib 2000), the current study could not find a significant difference in duration of vowels as a function of gender. It was also observed that gender did not interact with other factors such dialect, length, and phonetic environments to affect vowel duration in Oromo. However, previous studies reported that English,

Portuguese and Swedish speakers exhibited a significant durational difference in their vowels because of gender (Hillenbrand et al. 1995; Clopper, Pisoni & de Jong 2005). In such studies, women had significantly longer vowels than men, and in the current study, women also had longer vowels, though not significantly. The tendency of female talkers to produce longer vowels may be related to their attempt to make clear vowels, as clearly spoken vowels are known to have longer durations (Durisala, Nambi, & Batra 2011; Tjaden et al. 2014). This view is in discord with the finding that women's speech is more intelligible than men's (Bradlow, Torretta, & Pisoni 1996). More work remains to be done to investigate the effect of gender on duration of vowels in different languages.

There are clear dialectal differences with respect to the duration of vowels in Oromo. Mean durations of the vowels vary significantly across dialects, with the longest duration in the Eastern dialect and the shortest duration in the Western dialect. According to Kebede (2009), the Eastern dialect includes Oromo speakers living in Bale, a large part of Arsi, Hararghe, while the Western dialect includes most parts of Showa, Wollega, Jimma and Ilubabor. Unlike speakers from the Western dialect, speakers from the Eastern dialect tend to reduce vowels at a word boundary in a phrase (Owens 1985) and listeners of the other dialects often complain that they speak fast. As a result, we expected that speakers from this dialect would have a shorter vowel duration, but our expectation was not confirmed. Post Hoc multiple comparisons indicated that mean differences between the Eastern and Western dialects, and the Central and Northern dialects were significant. Many previous studies also reported a significant effect of dialect on vowel duration in American English, British English, Portuguese, Welsh and Dutch (Fox & Jacewicz 2009; Clopper, Pisoni, & de Jong 2005; Williams & Escudero 2014; Escudero et al. 2008; Mayr & Davies 2011) while some other studies found no such significant durational difference among dialects (Schoormann, Heeringa, & Peters 2017).

6. Conclusions

The current study has revealed that regional dialect is an important source of systematic variation in vowel duration in Oromo, with the longest duration in the Eastern dialect and the shortest duration in the Western dialect. Vowel duration does not vary with gender, but vowels have significantly longer duration when followed by voiced singletons than voiceless ones, and when followed by voiced singletons than by voiced geminates. Phonologically long vowels are, on average, two times longer than short ones. This difference is significantly affected by dialect and consonantal environments. A significant durational variation was observed among different vowel categories of the language. It is concluded that vowel duration in

Oromo is influenced by vowel categories, dialectal background of speakers and consonantal environments. Besides a quantitative variation, Oromo vowels are expected to exhibit a qualitative variation, and this phonetic aspect is worth considering in the future study.

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