The Acoustics of Geminates in Eastern Oromo

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Eastern Oromo, a Cushitic language of Ethiopia, is a language with phonemic geminate and singleton consonants. This study provides an acoustic description of Oromo's geminate stops. Oromo stops have a three-way laryngeal contrast (with some gaps) between aspirated, ejective, and voiced, as illustrated in Table 1. Therefore, through a number of acoustic measurements, the study investigates how these laryngeal contrasts are acoustically realized for geminates and whether the contrasts are realized in the same manner as Oromo's singleton stops'.

Table 1. Stops & affricates of Eastern Oromo (Fieldwork class, UofT, Fall 2013; Guutama 2004)

	bilabial	**coronal**	**post-alveolar**	**velar**	**glottal**
voiceless unaspirated					ʔ
voiceless aspirated		t̪ʰ, t̪ʰ:	tʃ:	kʰ, kʰ:	
voiced	b, b:	d̪, d̪:	d͡ʒ, dʒ:	g, g:	
ejective	p', p':	t̪', t̪':	t͡ʃ', tʃ':	k', k':	
implosive		ɗ, ɗ:			

The study examines the singleton and geminate ejective, aspirated, and voiced dental and velar stops of 8 native speakers (4 male, 4 female) of Eastern Oromo. Measurements of closure duration, voice onset time, burst duration, and maximum burst intensity were made to the stops. In addition, following Wright, Hargus, & Davis (2002) and Vicenik (2010), measurements of F0, intensity rise time, and spectral tilt (H1-H2) were made to the onsets and middles of the vowels following the stops. Statistical analysis was done in SPSS using repeated measures ANOVAs.

As expected, closure duration was a major cue to Oromo geminates. Geminate stops had significantly longer closures (M=124ms) than singletons (M=55ms) (F[2, 12] = 54.636, p<.001). Ejective geminates were shorter (M=108ms) than aspirated (M=131ms) and voiced (M=133ms) geminates (F[4, 24] = 3.350, p=.026), but singleton ejectives did not differ in closure duration from singleton aspirated and voiced stops.

Voiced geminates are cross-linguistically uncommon due to the effort needed to sustain voicing throughout the closure (Hayes & Steriade 2004, Kawahara 2015). Oromo seems to be a language such as Berber and Japanese that has semi-devoiced geminates; however that is not to say that fully voiced geminates are not also present in the language. In Oromo, it is variable whether voiced geminates are voiced or not: they were truly voiced in 76/214 (36%) tokens, had partial voicing in 63/214 (29%) tokens, and were completely voiceless in 73/214 (34%) tokens.

Oromo geminate bursts generally varied by laryngeal contrast in the same ways as singleton bursts. The VOT and burst duration measurements indicated that the releases of ejective (M=47ms) and aspirated stops (M=49ms) were significantly longer than those of voiced stops (M=10ms) (F[2, 12] = 83.098, p<.001). This was due to aspiration in the case of aspirated stops and a period of silence/laryngeal closure following the burst in the case of ejective stops. When considering only the burst portions of the releases, aspirated stops had short bursts (M=12ms) not significantly longer than the bursts of voiced stops (M=10ms) while ejective stops had longer bursts (M=25ms) (F[2, 12] = 42.977, p<.001). There were also intensity differences depending on the laryngeal contrast: aspirated stops were significantly quieter (by about 4 dB) than voiced stops (F[2, 10] = 17.415, p=.001) while ejective bursts were intermediary.

In some languages, geminate stops have louder bursts than singleton stops (DiCanio 2008). This does not seem to be the case in Oromo; however there were differences between singleton and geminate bursts. A significant interaction suggested that geminate voiced stops had quieter bursts than singleton voiced stops (F[4, 20] = 4.755, p=.007), and geminate stop bursts were significantly longer than word-medial singleton bursts (F[2, 12] = 17.923, p<.001).

Apart from F0, coarticulation with the following vowel does not seem to provide strong cues to the geminate-singleton contrast, nor to the three-way laryngeal contrast. Geminates were followed by higher F0 at the beginning of the vowel than word-medial singleton stops ($F[1, 6] = 7.597$, $p=.033$). Ejectives lowered the F0 of the vowel ($F[2, 12] = 3.986$, $p=.047$) but post-hoc tests revealed this trend not to be significant. Vowels were found to reach maximum intensity at a similar rate no matter the laryngeal type or length of the preceding consonant, and although spectral tilt measurements indicated aspirated stops were followed by vowels with breathier phonation, this was not significant. This is surprising given that in a previous study of Oromo singleton stops, vowel phonation was found to distinguish the laryngeal contrast (Percival 2014). This may be a result of being unable to control for vowel context in the geminate tokens since in the previous study spectral tilt also varied by vowel (Percival 2014). If vowel context were controlled for, perhaps a similar pattern would emerge for the geminate stops as for the singleton stops in the previous study, or perhaps vowels following geminates would be creakier, as Idemaru & Guion (2008) found for Japanese. Further research is currently underway to provide an analysis controlling for vowel quality. I am also investigating vowels preceding the stops since geminates have been found to affect F0 and duration of preceding vowels (Kawahara 2015).

To conclude, Oromo geminates differ from Oromo singleton stops mainly based on durational properties (closure and burst duration), and F0 of the following vowel. They are similar to singleton stops in how they differentiate the three way laryngeal contrast between aspirated, ejective, and voiced using burst intensity, release duration, and F0, but differ from singleton stops in that they may not rely on vowel phonation coarticulation as much as singleton stops and in that shorter closure duration is an additional cue to ejective geminates.

References

DiCanio, C. T. *The Phonetics and Phonology of San Martin Itunyoso Trique*. PhD dissertation: UC Berkeley.

Guutama, I. (2004). *Qooqaa addaa Afaan Oromoo/Special Oromo dictionary*. New York, NY: Gubirmans Publishing.

Hayes, B. & D. Steriade. (2004). Introduction: the phonetic bases of phonological Markedness. In B. Hayes, R. Kirchner, & Donca Steriade (ed.s) *Phonetically Based Phonology*. New York, NY: Cambridge University Press.

Idemaru, K, & S. Guion. (2008). Acoustic covariants of length contrast in Japanese stops. *Journal of International Phonetic Association,* 38, 167–186.

Kawahara, S. (2015). The phonetics of sokuon, obstruent geminates. In H. Kubozono (ed.) *The Handbook of Japanese Language and Linguistics: Phonetics and Phonology*. Mouton. pp. 43-73.

Percival, M. (2014). Variation in Ejectives: An Acoustic Study of Stop Contrasts in Eastern Oromo and Délı̨nę Slavey. Unpublished master's thesis: University of Toronto.

Vicenik, C. (2010). An Acoustic Study of Georgian Stop Consonants. *Journal of the International Phonetic Association*, 40, 59–92.

Wright, R, Hargus, S, & K. Davis. (2002). On the categorization of ejectives: Data from Witsuwit'en. *Journal of the International Phonetic Association*, 32, 43–77.