

Probing the limits of coordination: Word onset clusters in Georgian

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This study investigates coordination patterns in Georgian word onset clusters. The results confirm the presence of complex onsets in Georgian, but also reveal that the limits of coordination are reached with (extremely) long consonant clusters in word initial position.

Motivation: Georgian is a Kartvelian language with extremely long word onset consonant clusters, due in part to verbal morphology. A number of studies in the framework of Articulatory Phonology (Browman & Goldstein 1992) provided evidence that syllable structure is reflected in the coordination of articulatory gestures. Thus, the organization of consonantal gestures with respect to the following vowel depends on the cluster forming a complex onset or a simple onset coordination (overview in Hermes et al. 2017). Goldstein et al. (2007) provided preliminary evidence that Georgian clusters exhibit complex onset coordination. The data, however, are from only two speakers, who each reveal different strategies. Our study extends the investigation to clusters of different length and composition. In particular, CCC vs. CCCC clusters have not been tested before.

Method: The speech material (Table 1) consists of verbal roots beginning with one and two consonants, to which the person prefixes /v-/ , /g-/ and /gv-/ are affixed. We included an additional subset of monomorphemic non-verbal lexemes /riali, k'riali, (ts'riali), ts'k'riali/ (also tested in Goldstein et al., 2007), /ravi, kavi, kravi/ and /mari, kari, kmari/. To analyze gestural coordination patterns, we recorded articulographic data (EMA AG501) from 4 native speakers of Georgian (3 females). Target words were repeated 7 times, embedded in the carrier phrase: *ბოცყვა _ გამოთქმის ორჯერ* /sit'q'va _ gamoikmis ordzer/ ('I say the word _ twice'). To calculate timing relations between the articulatory gestures we identified all consonantal targets and the following vocalic target (Euclidian lip distance for labial Cs, i.e. minima, and for the V target, i.e. maxima; and maxima in tongue tip movement for coronal and tongue dorsum movements for velar Cs). As an indicator for C-center coordination, we took the rightmost C in a cluster. In complex onsets, we expect this C to be shifted further right towards the vowel, to make room for the added C.

Results: In line with Goldstein et al. (2007), word onsets of non-verbs did show a C-center coordination, with the rightmost C being shifted towards the following vowel. Fig. 1(a) displays the results averaged across speakers for /r, kr, ts'r, ts'kr/, where the target of /r/ is shifted towards /i/, when a C is added (e.g. mean shift: /r/-/kr/=26ms). This was also the case for /km/ in /kmari/ and /kr/ in /kravi/ (mean shift: /m/-/km/=15ms; /r/-/kr/=26ms). Figs. 1(b-d) display the timing of the C targets with respect to V for 3 different sets of verbal lexemes across the 4 speakers. Here, the C-center coordination can also be observed, comparing C to CC clusters (e.g. /d/-/vd/, /t'-/vt'/). Increasing cluster complexity also entailed a global coordination in e.g. CC vs CCC in /vd/-/gvd/ clusters (e.g. mean shift: =31ms), but not in /ts'm/-/vts'm/ (mean shift=2ms), nor in CCC to CCCC, i.e. /vts'm/-/gvts'm/ (mean shift=7ms).

Discussion/Conclusion: Although a global coordination defined as C-center coordination is only systematically observed for C – CC, we assume that all the clusters under investigation have the same phonological structure, i.e. complex onsets in Georgian – independent of the number of initial consonants. A possible explanation could be that the speech system reaches its physical limits for a global coordination. This may be related to the large inventory of word onset clusters to be maintained in Georgian, and/or to V recoverability. If the rightmost C in a cluster is shifted with increasing complexity of the onset, eventually the V may be entirely hidden (unless it is itself lengthened). A detailed, extended articulatory analysis of all cluster consonants (also depending on manner and place, cf. Chitoran et al. 2002) will be presented at the conference.

Table 1: Speech material examples for Georgian word onset clusters.

	Ø	v-	g-	gv-
C	დებ /deb/ 'you put (it)'	ვდებ /vdeb/ 'I put (it)'	გდებ /gdeb/ 'I put you'	გვდებ /gvdeb/ 'you put us'
	ტებ /t'ex/ 'you break (it)'	ვტებ /vt'ex/ 'I break (it)'	გტებ /gt'ex/ 'I break you'	გვტებ /gvt'ex/ 'you break us'
CC	დგები /dgebi/ 'you stand'	ვდგები /vdgebi/ 'I stand'	გდგები /gdgebi/ nonce	გვდგები /gvdgebi/ nonce
	წმენდ /ts'mend/ 'you clean (it)'	ვწმენდ /vts'mend/ 'I clean (it)'	გწმენდ /gts'mend/ 'I clean you'	გვწმენდ /gvts'mend/ 'you clean us'

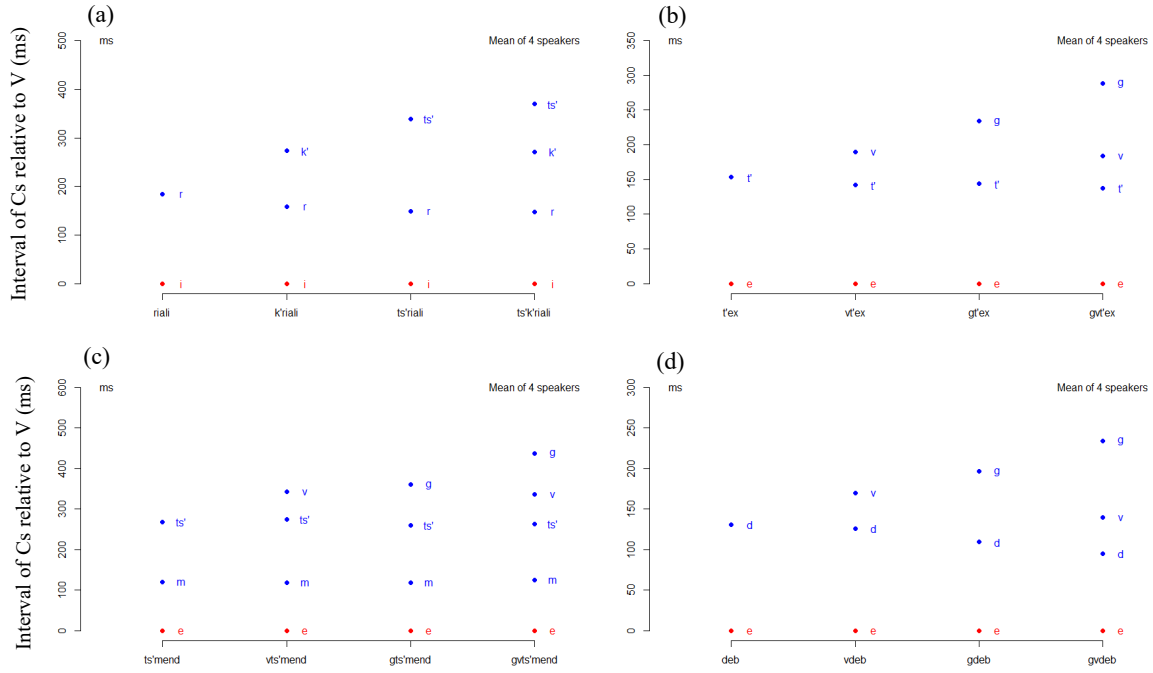


Figure 1: Articulatory timing of consonantal gestures relative to vocalic target averaged across speakers in /riali, k'riali, ts'riali, ts'k'riali/, /t'ex, vt'ex, gt'ex, gvt'ex/, /ts'mend, vts'mend, gts'mend, gvts'mend/ and /deb, vdeb, gdeb, gvdeb/.

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