Word-Initial Clusters in Tashlhiyt Berber: how perception informs phonological processing

There is general agreement among phonologists that the most common and unmarked syllable type is universally CV. For languages that have consonant clusters in the onset position, there are commonalities in the restrictions that the clusters obey. On top of these are sonority principles that disallow not only clusters with non-rising profile (SSP, Selkirk, 1984; Clements, 1990; Blevins, 1995) but also those that are not maximally distinct (sonority distance, sonority dispersion).

Tashlhiyt Berber is known for its extensive use of consonant clusters, many of which contravene the SSP by containing plateau or sonority-decreasing sequences (e.g. *kti* 'remember', *sti* 'sort', *rxu* 'be easy'). Since the mid-eighties, it has been proposed that clusters of this type as well as those with rising sonority do not form complex onsets; rather, they contain heterosyllabic consonants reflecting Tashlhiyt's typologically unusual allowance of any consonant to be syllabic (cf. Dell & Elmeldlaoui 1985, 2002, Boukous 1987). This hypothesis has been explored by Ridouane, Hermes, and Hallé (2014). They have provided phonetic evidence from native speakers, showing that the duration between the coda and the vowel-adjacent consonant remains stable despite the number of consonants appearing in the onset position. This is in contrast with true "complex onset" languages such as English where the duration of vowel-adjacent consonants is reduced when the onset contains more than one segment: For isntance, the /k/ in *scab* and the /l/ in *plug* is shorter than the initial consonants in *cab* and *lug*, respectively (see Marin & Pouplier 2010).

We here present the results of a recent study which aimed to explore whether clear speech, a type of listener-oriented, intelligibility-enhancing mode of speaking, improves the perception of word-initial consonant clusters in similar ways as for more typologically common singleton onsets. Clear speech is characterized by a variety of acoustic modifications relative to casual speech, such as slowing the speech rate and producing more extreme articulatory movements (see Picheny et al. 1986, Cohn & Zellou 2021, Cohn et al. 2022, among others). In Tashlhiyt, we compared clear and casual speech productions of the perception of a three-way word-initial contrast: singleton consonant (e.g. *sin* 'two', *lan* 'they have', *dar* 'at'), consonant cluster with varied sonority profiles (e.g. *fsin* 'they untied', *flan* 'someone', *ʁdar* 'in+at') and geminate (e.g. *ssin* 'with two', *llan* 'they exist', *ddan* 'they went'). We also measured their acoustic properties in both clear and casual speech. Participants recruited for the perception study consisted of 28 native speakers of Tashlhiyt Berber and 28 non-Tashlhiyt-speaking participants from the UC Davis Psychology subjects' pool, all of them reported no hearing impairments. The experiment was conducted online using Qualtrics. The stimuli were produced by a native speaker of Tashlhiyt in clear and casual style.

The acoustic part of the study showed that there was no significant difference in consonant duration between singleton and complex onsets ($p = 0.86$). The table below summarizes these acoustic measurements.

- Means (and standard errors) of acoustic values for each onset type by speech style.

	Single		Complex		Geminate	
	Clear	Casual	Clear	Casual	Clear	Casual
V-adjacent C duration (ms)	106.4 (13.3)	71.0 (10.0)	93.5 (7.8)	65.6 (6.8)	191.9 (21.1)	141.2 (13.0)
V duration (ms)	129.6 (1.9)	52 (3.8)	115.6 (5.7)	57.8 (3.4)	120.6 (6.6)	65.6 (4.9)
V intensity (dB)	77.7 (1.1)	73.7 (0.6)	76.6 (1.4)	73.6 (0.5)	76.6 (1.1)	73.3 (0.5)

The observation that singletons and vowel-adjacent consonants in complex onsets are not different in duration is consistent with the claim that prevocalic consonant clusters in Tashlhiyt are heterosyllabic (Ridouane, Hermes & Hallé, 2014).

On the perceptual side, however, we found that listeners, both native and non-native (naive), are less sensitive to word-initial contrasts involving typologically rarer sound combinations. We performed a post-hoc analysis on the trials containing complex onsets to compare perceptual sensitivity to clusters containing non-rising sonority to those with rising sonority across speaking styles. We computed a d-prime score for rising and non-rising sonority clusters for each participant and for each speech style. The results in figure 1 show that the listeners' ability to discriminate word pairs which contain a rising-sonority complex onset improves in clear speech, as opposed to the discrimination of non-rising sonority complex onsets which decreases in clear speech.
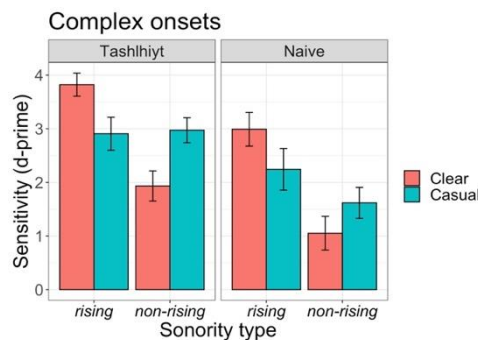

Figure 1. Native and naive listeners' mean sensitivity (d-prime scores) for Tashlhiyt clusters contrasts by sonority type and speaking style (error bars depict standard error of the mean).

The fact that clear speech enhances the perception of word-initial rising sonority clusters reflects, we argue, a core property that has little to do with syllable structure but that distinguishes rising clusters from falling and plateau clusters in Tashlhiyt. We contend that native speakers use a salient phonotactic property that underlies the arrangement of segments within verbs in Tashlhiyt, the same as noted by Lahrouchi (2010): rising sonority clusters of the type Obstruent-Sonorant form a head complement structure, where the obstruent is the head and the sonorant its complement. This is illustrated below with the verbs *bdr* 'mention' and *frg* 'enclose' (the head position is indicated by the dot at the end of the branch):

This binary-branching structure turned out to be decisive not only in selecting among triconsonantal verbs those that geminate the initial consonant in the imperfective (**fr**g (aorist) → ffrg (imperf)) and those that geminate the medial consonant (b**dr** (aorist) → bddr (imperf)) but also in adapting the fricative rhotic [ʁ] in loanwords from French as a sonorant tap [ɾ] in Berber (e.g. *train* [tχɛ̃] → [trææn], see Lahrouchi 2020). Given the active phonological role of the obstruent-sonorant cluster in Tashlhiyt and its high frequency in the lexicon (94% of the verbal roots examined in the original work contain a sonorant-obstruent cluster, see Lahrouchi 2010: 261), it is not surprising that native speakers perceive them better and faster than falling sonority and plateau clusters, as our perceptual study showed.

Selected references

Lahrouchi, M. 2010. On the internal structure of Tashlhiyt Berber triconsonantal roots. *Linguistic Inquiry* 41(2): 255-285.

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Ridouane, R., Hermes, A. & Hallé., P. 2014. Tashlhiyt's ban of complex syllable onsets: Phonetic and perceptual evidence. Language Typology and Universals 67(1): 7–20.