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The temporal organization of complex onsets and codas in Romanian: A gestural approach

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ABSTRACT

This study investigates the temporal organization of a variety of onset and coda consonant clusters in Romanian on the basis of articulatory data from five speakers. The results show that Romanian sibilant–initial complex onsets /sp-, sk-, sm-/ exhibit a global, ''c-center'' organization, while coda clusters /-sk, -sm, -ps, -ks, -kt, -pt, -mn/ exhibit a local, left-edge organization. These results are compatible with the predictions of the gestural approach to syllable organization (Browman & Goldstein, 2000, *Bulletin de la Communication Parlée*, *5*, 25–34) and corroborate the temporal patterns previously reported for American English and German. Stop-initial clusters /ps-, ks-, kt-, kn-/ on the other hand show a temporal organization at odds with the predictions for onsets, and not readily explainable by additional considerations such as recoverability requirements. The observed temporal pattern may reflect cluster composition particularities, or alternatively a syllable parse different from that of sibilant-initial clusters. The stop-initial cluster results underline the need for systematic cross-linguistic studies on the temporal organization of clusters of varying composition.

1. Introduction

The syllable has long been recognized as an important unit of linguistic organization. In the quest for physiological correlates of this unit, the temporal coordination of articulatory gestures has emerged as a consistent locus of differentiation between syllable positions (Browman & Goldstein, 1988; Byrd, 1995, 1996; Byrd, Tobin, Bresch, & Narayanan, 2009; de Jong, 2003; Gick, 2003; Giles & Moll, 1975; Honorof & Browman, 1995; Krakow, 1999; Löfqvist & Gracco, 1999; Sproat & Fujimura, 1993). This work has shown that prevocalic (onset) and postvocalic (coda) syllable positions are defined by specific timing patterns holding between articulators within a consonant (such as the velum and oral gesture for a nasal), between successive consonants, and between consonants and vowels. Concerning particularly the timing between consonants and vowels, it has been observed that consonants in onsets start roughly synchronously with the vowel, and as a result they overlap more with it than consonants in the coda (de Jong, 2003; Löfqvist & Gracco, 1999). In addition, onset clusters have been shown to reorganize temporally as a unit, relative to singleton timing, while no such reorganization has been observed for coda clusters (Browman & Goldstein, 1988; Byrd, 1995; Honorof & Browman, 1995). Specifically, it has been observed that as more consonants are added to the syllable onset, the rightmost consonant (e.g. /p/ in *pat* vs. *spat*) shifts towards the vowel, while the leftmost consonant shifts away from the vowel, such that the singleton and the cluster line up most stably along their midpoints (centers) rather than along their edges (Fig. 1). No such temporal shift has been observed for complex codas; rather, consonants in coda clusters are added sequentially to each other, resulting in a line-up of singletons and clusters along their left edge (Fig. 1). These empirical observations have led to the proposal that onset clusters are timed globally with the following vowel, so that the temporal midpoint of the entire cluster – the so-called ''c-center'' – maintains a stable relationship with it, regardless of number of consonants in the onset. In contrast, coda consonants have been hypothesized to be timed locally with the preceding vowel, with the left-edge and vowel maintaining temporal stability regardless of number of consonants in the cluster (Browman & Goldstein, 1988, 2000).

However, as shall be detailed below, empirical evidence supporting the temporal differences between (complex) onsets and codas has so far been restricted in terms of both cluster types and languages examined, with recent work showing that the temporal organization hypothesized for complex onsets may not uniformly hold cross-linguistically (Pouplier & Beňuš, 2011). The aim of this paper is therefore to examine the extent to which timing patterns characterizing typical English onset and coda clusters are generalizable across language and cluster types. To this end, we investigate the temporal organization of consonant clusters in a new language, Romanian, over a wide range of cluster types: sibilant-stop

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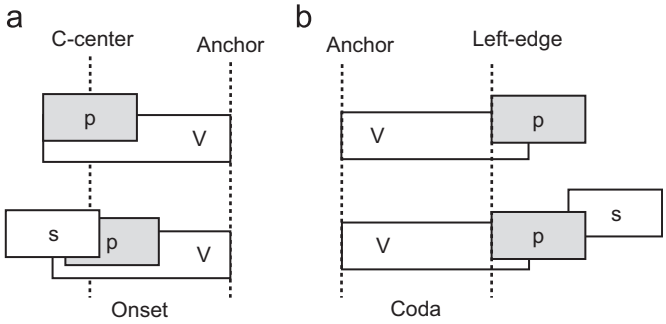

Fig. 1. Schematic timing pattern hypothesized for onsets (left) and codas (right). The anchor is a fixed reference point within the word with respect to which timing across singletons and clusters is assessed. Boxes are schematic temporal representations of consonants and vowels.

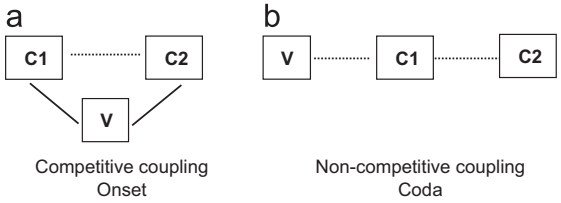

Fig. 2. Phasing relations hypothesized by the gestural approach to syllable organization for complex onsets (left) and codas (right). In-phase coordination is indicated by continuous lines, anti-phase coordination by dotted lines.

clusters (e.g. /sk/), stop-obstruent clusters (e.g. /ks/), and stop-stop clusters (e.g. /kt/) in both syllable-initial (onset) and syllable-final (coda) position.

Experimentally, two distinct timing patterns, synchronous vs. sequential, have been revealed as characterizing onset and coda positions, respectively. Thus, it has been shown that the articulatory gestures within a consonant, such as the velum and oral gesture of a nasal consonant, or the tongue dorsum retraction and tongue tip raising of a lateral consonant, start at roughly the same time in onset position, but follow each other sequentially in coda (Browman & Goldstein, 1995; Byrd et al., 2009; Krakow, 1993; Sproat & Fujimura, 1993). Also, the consonant as a whole has been shown to be timed roughly synchronously to the vowel if it precedes it, but sequentially if it follows it (de Jong, 2003; Löfqvist & Gracco, 1999). Formally, these distinct timing patterns as a function of syllable position have been hypothesized to arise from specific coupling modes – in-phase, and anti-phase, that speech is assumed to employ, similar to other domains of coordinated skilled actions (Browman & Goldstein, 2000; Goldstein, Byrd, & Saltzman, 2006; Nam, Goldstein, & Saltzman, 2009; Pouplier, 2011 for an overview). As such, syllables and syllable organization are viewed as epiphenomena to particular patterns of coordination between consonants and vowels (although recent modeling research has suggested that additional timing effects may further modulate such underlying coordination patterns, cf. Shaw, Gafos, Hoole, and Zeroual (2011)).

Specifically, the onset pattern (the synchronous, greatly overlapping CV pattern) is assumed to be the result of in-phase coupling between the consonant and the vowel, while the coda pattern (the sequential, less overlapping VC pattern) is hypothesized to result from anti-phase coupling. Multiple onset consonants are assumed to be coupled in-phase with the vowel (onset-mode), but anti-phase with each other to ensure recoverability (Fig. 2). This results in competitive coupling demands on the gestures, demands that cannot be fully met at the same time, i.e. onset consonants cannot be at once all synchronous with the vowel and sequential to each other. The ''c-center'' organization (cf. Fig. 1), with the rightmost consonant shifting towards the vowel and the leftmost consonant shifting away from it relative to their timing as a singleton, represents the ''compromise'' solution that best satisfies the competing requirements hypothesized for complex onsets. On the other hand, multiple coda consonants are assumed to be coordinated anti-phase to each other, with only one of the consonants being directly coordinated to the vowel (Fig. 2); no competitive demands result from this coupling mode (Browman & Goldstein, 2000; Nam et al., 2009). This set of hypotheses will be referred to as the gestural approach to syllable organization.

There have been several recent attempts to systematically test the predictions of the gestural approach to syllable organization, both in English, and cross-linguistically, with partly mixed results. Following earlier studies on American English (Browman & Goldstein, 1988; Honorof & Browman, 1995), a ''c-center'' organization for onsets has recently been confirmed for /sp-/, /sk-/, /sm-/, /pl-/, /kl-/ onsets in English (Marin & Pouplier, 2010), for /sk-/, /pl-, /bl-/, /km-/, /gm-/ in German (Pouplier, 2012), and for /pr-/, /pl/ in Italian (Hermes, Grice, Mücke, & Niemann, 2008). However, it has been disconfirmed for onset clusters in Slovak (Pouplier & Beňuš, 2011), although they are unequivocally assumed to be phonologically complex onsets, and at least some (e.g. /kl-/, /kr-/, /sm-/) are compositionally similar to onsets in English and German. The authors speculated that the organization of syllable margins (onsets) in this language may be affected by the type of syllable nuclei permitted,: thus, because the language allows consonantal nuclei, which require a specific timing with the onsets for production/recoverability reasons, even when the nuclei are vocalic, the onset and the vowel show a different timing patterns than in languages that do not allow phonological consonantal nuclei. Alternatively, according to Pouplier & Beňuš, the Slovak results may indicate that the onset-vowel coordination pattern proposed on the basis of English data may not hold universally, and that a greater variety of timing patterns is employed cross-linguistically than has been documented so far.

Fewer empirical studies have examined the temporal organization of complex codas (Byrd, 1995; Honorof & Browman, 1995; Marin & Pouplier, 2010 for English; Pouplier, 2012 for German), and they overall support the temporal organization predicted for codas. One exception were American English /l/-coda clusters (Marin & Pouplier, 2010), which showed great inter-subject variability in production, and a temporal