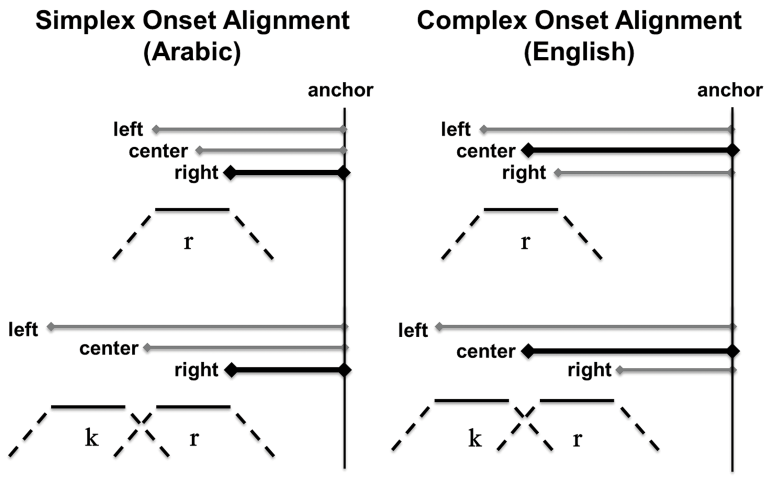

Figure 1: Local (Arabic) and global (English) consonant cluster organization: prototypes for simple and CC-cluster onsets showing the respective interval stabilities. From **?**, CC BY 4.0.

The question of how evidence for the relatively abstract concept of a syllable can be found in a continuous phonetic signal is relatively old. Looking at the timing relations between the onset and the rhyme can show underlying mental representation of syllables.

Global vs. local timing Phonotactics of languages differ in how syllables can be constructed and what kinds of clusters are allowed where in the syllable. Complex syllable onsets such as /ksl/ may be a valid onset in a language but not in another, while two languages where this onset is valid still differ in their temporal organization of those consonants with respect to the nucleus vowel of the syllable. There have been found two different kinds of consonantal onset organization:
"Global timing refers to the coordination of a sequence of consonants as a unit with respect to the vowels on either side. Alternatively, 'local timing' refers to the coordination of a single consonant gesture in a sequence with respect to a neighboring vocalic gesture. It has been hypothesized by (**?**) that both local and global timing play a role in coordinating consonant sequences with adjacent vowels." (**?**, 286)

A tool to determine which organization underlies the syllable of a language is the notion of stability. Depending on whether syllable onsets are organized locally or

globally, the duration of intervals between the relevant landmarks and a (post-)vocalic anchor varies more or less when more consonants are added to a onset cluster. Landmarks found to be relevant are the right edge (i.e. the offset of the last consonant before the vowel) as for example in Arabic (**?**) and the C-Center the midpoint between the target and the release of the syllable onset as for example in English (**?**). This stability measure can give a good hint at how syllables in languages are organized, but it is not always sufficient. The concept is illustrated in Fig. 1 (**?**). Besides the stability metric (**?**) finds other, more nuanced parameters which will be discussed below.

Spanish **?** looked at CCVC-syllables in Spanish, at their VOT, gestural plateau duration and gesture overlap. Concerning stability they found patterns that seemed to imply that Spanish does not allow complex syllable onsets (robust IPI) as Arabic does, which organizes consonant clusters locally. But, as opposed to Arabic, Spanish has been found to apply overall global timing by sotiropoulou2020global. In their paper **?** they found that the stability measure is not a reliable tool to detect the underlying syllable organization of Spanish. Other factors such as voicedness, and manner of articulation can play into the temporal organization of the tongue movements. For instance, the interval stabilities seemed to be quite variable; in voiced stop-lateral clusters, local timing interval stability was found and global timing interval stability in the other instances. So, only a stability metric is not enough to determine a general rule for a language, this is evidence "that syllable structure does not have consistent phonetic manifestations in the articulatory record." (**?**, 22). For sake of the simplicity of this paper, I will nonetheless focus on only stability and the influence of stress while being aware of potentially contradicting results.

Stress In general, according to **?**, Spanish has a lexical stress / word stress. This can be demonstrated in minimal pairs - or even minimal triples such as in example (1). Here, stress is represented by capitalization.

(1) TERmino - term, end
terMIno - finish.1SG.PRS
termiNO - finish.3SG.IPFV

These stressed syllables are marked acoustically by 'longer durations, higher fundamental frequency and higher intensity than unstressed syllables' (**?**, 215) although the overall pitch can vary depend on the position of the word in the whole phrase or sentence.

There have not been yet studies on the effect of stress in the temporary organization and articulation of Spanish syllables, but results from other languages and the influence of stress on articulation could give us a hint. For instance, in English it has been found by **?** that coarticulation is reduced in English stressed syllables and locally the articulation is shifted towards the hyperarticulate end of the continuum. A potential pitfall is that that while they "define stress as the set of prosodic categories which involve relationships of relative prominence between syllables."(**?**, 199) they look at nuclear accent on the whole phrase level in their analysis, which is not exactly what I will be doing (see **??**). So while intergestural timing is sensitive to the position of the gesture within the prosodic structure of the utterance the influence of stress at the word level is not completely clear.

Hypotheses We know now that stress probably will positively influence the timing of syllables since carefully articulated gestures are also longer in duration. I still suppose that the ratio of segment length to intergestural timing will remain the same, i.e. stress will not have an influence on the temporal syllable organization.