Effects of syllable structure and speech rate on H prenuclear peaks in Spanish

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In the recent years there has been more and more evidence that LH points in the tonal space behave as phonological targets. Indeed, H peaks of both nuclear and prenuclear pitch accents are produced with an amazing degree of stability in tonal scaling and alignment across languages (see Bruce 1977, Arvaniti et al. 1998, 2000; Ladd 1986; Liberman and Pierrehumbert 1984; Prieto et al. 1995, 1996; Silverman and Pierrehumbert 1990; Xu 1999, 2002, among others). Previous investigations on the alignment behavior of prenuclear accents in Spanish and in other languages have observed that while L values are consistently 'anchored' with the onset of the accented syllable, H positions are more variable. These studies have generally emphasized prosodic factors, and, specifically, the right-hand prosodic context on the location of accent peaks (upcoming accent or boundary tone, tonal crowding, vicinity to a prosodic boundary, etc.) –see Silverman & Pierrehumbert, 1990 for English; Prieto, van Santen & Hirschberg, 1995. However, a more recent line of work suggests that when such prosodic effects are excluded alignment of F0 targets are consistently governed by segmental **anchoring** and that strict alignment effects are pervasive under changes of syllabic/segmental structure and speech rate (Arvaniti & Ladd 1995 for Greek, Ladd et al. 1999 for English and Xu 1998 for Chinese; see also Schepman et al. submitted, for Dutch, Atterer & Ladd, to appear, for German). The idea behind all this evidence is that both the beginning and the end of a rising pitch accent are anchored to specific points in the segmental structure, regardless of segmental or syllable structure composition.

The goal of this study is to test the so-called 'anchoring hypothesis' for Castilian Spanish and examine whether LH points behave as segmental anchors in both nuclear and prenuclear position. The standard literature has shown that Spanish nuclear peaks always align with the stressed syllable, while prenuclear peaks are usually displaced to the right. In order to test prenuclear accents, we selected a specific prenuclear contour (one typically found in read speech) which did not exhibit peak displacement.

Experiment 1 focused on segmental and syllabic composition, while **Experiment 2** examined peak behavior under changes in speech rate. For Experiment 1, 4 speakers of Castilian Spanish read three times a corpus of 96 sentences exhibiting the phonological variety needed to test our hypothesis (open vs closed; complex vs. simple onset, as well as different consonant and vowel types), for a total of 1152 repetitions (96 utterances x 4 speakers x 3 repetitions). For experiment 2, the same speakers were told to read twice 32 target syllables in proparoxytone words, first at a normal speech rate, then at a fast rate and finally at a slow rate, for a total of 768 utterances (32 utterances x 3 speech rates x 4 speakers x 2 repetitions). For both databases, the test words appeared both in prenuclear and nuclear position.

Results of our pilot study with two speakers show that prenuclear Hs align with the end of the vowel, both for open and closed syllables, and regardless of speech rate and syllabic and segmental composition (even though slow rate displays some H retraction). The following table summarizes and compares our pilot results to those of other languages:

	Accent type	**H Alignment (segment & syllable offset)**
Greek (Arvaniti et al. 1995)	Prenuclear rising	C1
Dutch (Ladd et al. 1998)	Prenuclear rising	S0
Mandarin (Xu, 1998)	Rising rising	S0
English (Ladd et al. 1999)	Prenuclear rising	~C1
Japanese (Ishihara, 2003)	Initial H in accented accentual phrase	C1 (CV.CV); V0 (CVN.CV); _ 2nd mora onset
Spanish (pilot result)	Prenuclear rising	V0

Segmental and syllabic anchoring of trailing tones across different languages in contexts without tonal coarticulation. Segments: C=consonant, V=vowel, N=coda, S=syllable; Structure: 0=accented syllable, 1=postaccentual syllable (ex: C0V0N0.C1V1).

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