Timing Properties of (Brazilian) Portuguese and (European) Spanish

Isochrony, despite decades of research, remains controversial as to whether it provides a meaningful typology for classifying languages. Romance languages offer an interesting opportunity to address this question since closely related languages are often claimed to be at different ends of the typology and/or to exhibit combinations of properties; and there may be different assessments of the same language [1,2]. A substantial problem in assessing isochrony is that the experiments and analyses conducted on different languages are often methodologically divergent, and more fundamentally, the definitions of syllable- and stress-timing may vary [3,4,5,6]. In this paper, we analyze European Spanish (ES) and Brazilian Portuguese (BP), and instead of investigating isochrony *per se*, we contribute to the discussion by examining the interface between timing properties and prominence (lexical and sentential) properties. We propose that this approach allows us to abstract away from many of the methodological challenges, and view particular acoustic patterns that contribute to the general intuition of different rhythmic patterns underlying the isochrony controversy.

Since duration is frequently associated with prominence, we must ask whether the extent to which duration is altered in the manifestation of prominence depends on the rhythmic properties of a language. Specifically, it can be expected that syllable-timed languages would resist alteration of durations in the expression of prominence, while stress-timed languages would not be similarly constrained. We thus test two specific hypotheses:

(1) <u>Hypothesis 1 (stress effect)</u>: If ES / BP are syllable-timed, stressed vowels will not be longer than unstressed vowels.

(2) <u>Hypothesis 2 (focus effect)</u>: If ES / BP are syllable-timed, stressed and unstressed vowels will not exhibit differential lengthening properties due to focus.

In order to avoid possible confounds due to syllable structure and intervening elements between syllables (i.e., segments, boundaries), we compare vowels in stressed and unstressed CV syllables, in non-focus and focus conditions. The target vowels are in the first (unstressed) and second (stressed) syllable of real 3-syllable words with penultimate stress. There are 10 each of stressed and unstressed /i, u, a/ (e.g., ES: *caséta* 'hut', *butáca* 'arm chair'; BP: *cachórro* 'dog', *pedáço* 'piece') in each focus condition (elicited with dialogues). In total, there are 120 target vowels per speaker (ES: N = 9; BP: N = 4 + 5 in progress).

Vowel Duration, (mean) F0, ΔF0 (change from beginning to end of vowel), Intensity and Centralization were measured with Praat. The data were normalized using z-scores, yielding substantial corpora by pooling data across speakers and vowels. In order to not only test statistical significance, but also to identify potentially different roles among significant properties, we used Binary Logistic Regression Analyses to assess the distinguishability (i.e., classification) of stressed vs. unstressed vowels (Table 1) and focused vs. non-focused vowels (Table 2), as well as the individual roles of Duration, and any other significant properties. Only the strongest individual classifier is shown, or the strongest 2 if there is ≤5% difference.

		Stressed / Unstressed	
		Non-focused	Focused
ES	Overall	86%	89%
	Individual	F0 (82%)	F0 (86%), ΔF0 (81%)
BP	Overall	70%	86%
	Individual	Dur (69%)	F0 (84%), Dur (82%)

Table 1*. Classifications of Stressed vs. Unstressed Vowels*

		Focused / Non-focused	
		Stressed	Unstressed
ES	Overall	78%	67%
	Individual	Dur (73%)	Dur (60%), F0 (60%)
BP	Overall	85%	87%
	Individual	Dur (80%)	F0 (84%)

Table 2*. Classifications of Focused vs. Non-focused Vowels*

Regarding *Hypothesis 1*, Table 1 shows that stress is manifested by F0 properties in ES regardless of focus; duration is not manipulated as a primary cue for stress, supporting the assessment of ES as syllable-timed. In BP, however, the main cue for stress is duration in the absence of focus (i.e., left side of Table 1), the manipulation of duration being consistent with the classification of BP as *not* syllable-timed.

Regarding *Hypothesis 2*, Table 2 shows that while ES uses duration to cue focus, it does so on both stressed and unstressed syllables, again not differentiating their duration properties. In fact, the ratio of stressed/unstressed vowels is 1.0 in both focus and non-focus conditions. By contrast, BP shows differential use of duration in expressing focus in stressed and unstressed vowels, consistent with being *not* syllable-timed. While the ratio of stressed/unstressed vowels is 1.5 in the non-focus condition, under focus, extra lengthening of stressed vowels makes it 2.0.

In sum, comparisons of (lexical and sentential) prominence effects on duration of ES and BP support our hypotheses, strongly confirming a distinction between the rhythmic classes of the two languages. ES is syllable-timed since duration is not manipulated to express stress nor does it distinguish stressed/unstressed vowels under focus. BP is stress-timed – or at least non-syllable-timed – since it shows greater duration of stressed vowels and preferential enhancement of duration of stressed syllables under focus. These patterns will be further compared to similar data from French, for which preliminary results reveal patterns similar to those of ES.

Selected References

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