POSITION IN WORD EFFECTS REVISITED IN RELATION TO STRESS AND ACCENT EFFECTS

Miran Kim

Stonybrook University, USA
mi.kim@stonybrook.edu

ABSTRACT

Temporal characteristics of Position in Word (PoW) effects in Spanish are investigated in relation to stress and accent. The results show that initial /s/ is lengthened word-initially but only when stress or accent is concomitantly active. This suggests that the PoW effect is conditioned by stress and accent (prominence effects), and the word boundary effect enhances onset durations when combined with the prominence effects. The result is interpreted to mean that the PoW effect in Spanish could better be characterized as enhanced stressed/accent effects benefited by boundary initial positions. This study provides an important insight of prosody interactions that can help us to understand the complex nature of prosodic effects.

Keywords: position in word, stress, accent, prominence effects, prosody interaction

1. INTRODUCTION

The phonetic realization of a segment is greatly influenced by the prosodic structure in which it is located [3, 6, 9], and the effect may vary depending on the prosodic boundary that is hierarchically organized in the given language [13]. As one of such prosodic boundary effects, Position in Word (PoW) also affects segment(s) at word edges [7, 9, 11, 14]. For example, consonant durations and/or qualities (such as overall energy) tend to be longer/stronger word-initially than -medially. However, word level effects are not always found consistent in literature, possibly because interactions among prosodic factors were rarely considered in identifying PoW effects [7, 11, 14]. For example, Umeda [14] examined English consonant durations (in a 20-min essay reading data), and found that the mean duration of /s/ was longer word-initially than word-medially regardless of stress. She concluded that PoW as well as lexical stress was one of the most influential factors in the durational behavior of /s/. However, phrasal level prominence such as accent was not considered in [14]. The PoW effect was absent in Lavoie [11] for the same segment (English /s/), although she observed PoW effects in other segments such as stops. Lavoie used nonce words in a carrier sentence, where each target word was possibly accented. The apparently conflicting results suggest that there are possible interactions between PoW and other prosodic factors such as stress and accent.

This study examines durational details of PoW effects in the presence/absence of stress and accent effects, and provides a novel interpretation regarding the PoW effect in "stress-accent languages [1]".

2. SPEECH DATA

A total of 10 (Latin American: 5 Peruvian and 5 Argentinean, 6M and 4F) Spanish speakers participated in the recording. The task was to read lists of words in isolation (session 1) and then in carrier sentences (session 2).

Target syllables were all open (/s/V), and consist of onset /s/ and one of the five phonemic vowels /a, e, i, o, u/ in Spanish.[1] Each target syllable appeared either word-initially or –medially in a tri-syllabic lexical word, which varied in stress (initial or penultimate stress). For example, the two stressed /so/ syllables in *sótano* 'n. basement' and *pasóta* 'n. dropout' differ in PoW, while the two word-initial /se/ syllables in *séquito* 'n. followers' and *secádo* 'n. drying' differ in stress. There were also 40 filler words, whose onsets were other than /s/.

Target words were embedded in one of the three frame sentences in (1).

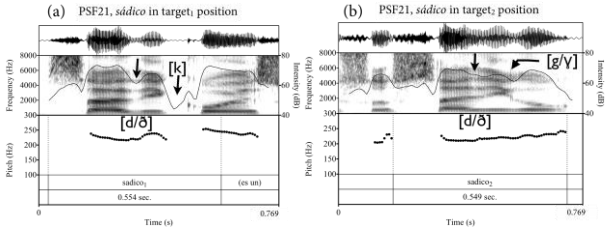
(1) a. ***Target***$_1$ es un sustantivo, y uso ***Target***$_2$ con un adjetivo.
'***Target***$_1$ is a noun, and I use ***Target***$_2$ with an adjective.
b. ***Target***$_1$ es el apellido de a'lguien, y uso ***Target***$_2$ con su nombre.
'***Target***$_1$ is a last name of someone, and I use ***Target***$_2$ with his/her first name'
c. ***Target***$_1$ es un imperativo, y uso ***Target***$_2$ para pedir algo.
'***Target***$_1$ is an imperative form, and I use ***Target***$_2$ to give commands'

When the frame sentence (1a) is used, the underlined word was modified if necessary to

accommodate the grammatical categories of target words: e.g., for the word *sádico* 'a. sadistic', the frame sentence was modified into *Sádico es un adjetivo y uso sádico (target$_2$) con un sustantivo* ('Sádico [=target$_1$] is an adjective and (I) use sádico [target$_2$] with a noun'). A total of 1200 tokens of /s/ from session 2 were analyzed: 10 subjects × 3 repetitions × 5 syllables (/sa, se, si, so, su/) × 2 accent conditions (accented/unaccented) × 2 stress conditions (stressed/unstressed) × 2 PoW conditions (word-initial/word-medial).

The segmental realization of the second occurrence of a target word differs from that of the first one. Some studies on spontaneous speech have shown that phonemic voiceless stop [p, t, k] in some varieties of Spanish may undergo lenition [8, 12] (e.g., /p, t, k/ realize as voiced stops or approximants). In the current data, we also find that intervocalic unstressed voiceless stops are often lenited as shown in Fig. 1.

Figure 1: Different phonetic realizations of stops in the target$_1$ and target$_2$ positions.



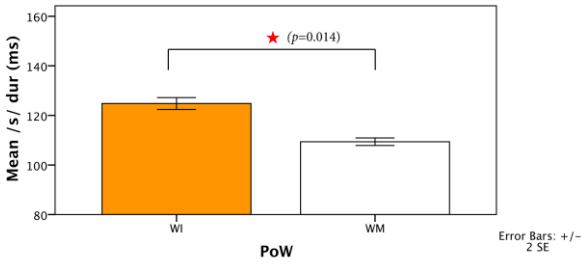
In Fig. 1b, the /k/ in *sádico* 'adj. sadistic' is realized as [g] or even as [ɣ]. It is important to note that this lenition occurs only in the second occurrence of a target word (Fig. 1b), and never in the first position (Fig. 1a). The degree of lenition of /d/ is also greater in (b) than (a), which is evident in the formant structure near the stop and also in the energy curve. That is, the /d/ in (b) shows clearer formant structure and relatively higher energy level compared to those in (a), both of which indicate a weaker constriction for /d/ in (b). The fact that this voiceless stop lenition (if it occurs) is restricted to the second position strongly suggests that the two positions are prosodically distinct at some higher level in the prosodic structure. The second target position is taken in this study as being unaccented in opposition to the prosodic context of the first target.

Segmental durations (/s/ and vowels) are acoustically identified through an inspection of both waveforms and spectrograms: the beginning of aperiodic fricative (C-onset), the voicing initiation (first glottal peak, C-offset=V-onset), and the maximum changing point of the second formant (V-offset). In the following section, the PoW effect is compared between these two positions as well as between stressed and unstressed conditions.

3. RESULTS

The overall results show that the duration of /s/ is longer word-initially than word-medially, indicating initial segment lengthening.

Figure 2: Overall PoW effects pooled across stress and accent conditions.



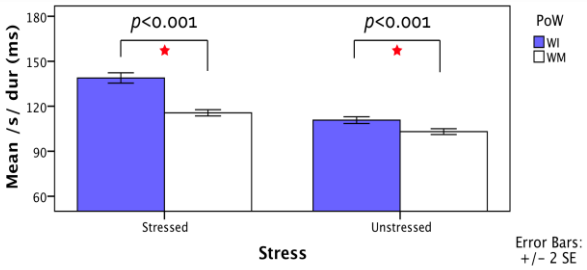
The mean durations of word-initial and -medial /s/ are 124.8 ms (N=600, SD=27.7) and 109.4 ms (N=600, SD=17.6), respectively. A repeated measures ANOVA confirms that there is a main effect of PoW on the duration of /s/ [$F_{(1,9)}$=8.94, p=0.014]. There is no difference in the duration of vowel between the two positions (p>0.5).

In the following sections, PoW effects are compared between stressed and unstressed conditions, and then between accented and unaccented conditions (as specified in the previous section). Interactions among PoW, stress, and accent are also discussed.

3.1. PoW and stress effects

The PoW effect is present regardless of stress condition such the durations of both stressed and unstressed /s/ are longer word-initially than word-medially. Fig. 3 shows the overall PoW effect.

Figure 3: PoW effects in relation to stress (pooled across accent conditions).

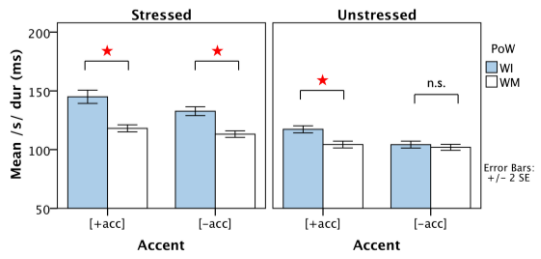


The average duration of /s/ is longer word-initially, and the PoW effect is greater for the stressed /s/ (22 ms longer for word-initially stressed /s/ and 7.7 ms for word-initially unstressed /s/). The mean differences by PoW are statistically significant for both stressed and unstressed /s/ according to One-way ANOVAs: PoW on the stressed /s/ [$F_{(1,599)}$=26.84, p<0.001] and PoW on the unstressed /s/ [$F_{(1,599)}$=132.95, p<.001). As two independent variables, both PoW and stress have a main effect on the /s/ duration [PoW: $F_{(1,9)}$=8.94, p=0.014; STRESS: $F_{(1,9)}$=54.45, p<0.001]. There is also an interaction between Stress and PoW such that the PoW effect is greater for the stressed /s/ than the unstressed counterpart [$F_{(1,9)}$=5.15, p=0.047].

3.2. PoW and accent effects

The PoW effect is present regardless of accent condition and the effect increases in the accented condition. The duration of /s/ is longer word-initially than –medially in the two accent conditions, and the effect tends to be greater for the accented /s/. Accent as a main effect is marginally significant: [$F_{(1,9)}$=5.08, p=0.051]. There is no interaction between PoW and Accent. In Fig. 4, PoW effects are separated by stress and accent conditions.

Figure 4: PoW effect in relation to stress and accent.

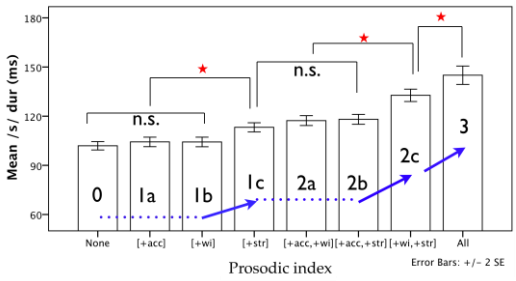


Note in Fig. 4 that the word-initial /s/ is longer in the accented condition compared to the unaccented condition, but no difference is found for the word-medial /s/ between the two accent conditions. Interestingly, the PoW effect becomes absent if the unstressed /s/ is also unaccented. In other words, the durational differences by PoW are retained only in the either accented or stressed syllables. For the stressed syllables (left panel), the PoW effect is present regardless of the accent condition. The PoW effect of the unstressed /s/, on the other hand, is present only in the accented condition and disappears in the unaccented condition. In other words, when initial syllables are neither stressed nor accented, the initial segment is not lengthened. This suggests that the PoW effect is the positional enhancement of stress and/or accent effects, and is conditioned by prominence factors.

3.3. Prosody interactions

We have seen earlier that there was an interaction between Stress and PoW (Section 3.1), but neither between Accent and Stress, nor between Accent and PoW. This means that PoW effects are in fact the enhanced temporal effect of stress/accent in this language. In order to schematically show how the lengthening of /s/ occurs depending on either single or combinatory prosodic factor(s), we separate the lengthening patterns according to changes in prosodic factors. For the purpose of simplicity, each factor is transformed into additive and categorical features (e.g., [±stress], [±accent], and [±word-initial]). Abstract prosodic strength is represented by a numeric index (number of active prosodic factors: 0~3), which is defined as follows: "None ([-str,-acc,-wi])", "1 (only one factor is positive, e.g., [+stress, -accent, -wi] or [-stress, -accent, +wi])", "2 (two factors are positive, e.g., [+str,+acc,-wi] or [-str, +acc,+wi])", and "3 ([+str,+acc,+wi])". According to these indices, "0" is prosodically the weakest and "3" is the strongest context. In Fig. 5, the durational changes of /s/ are arranged by the prosodic index defined above.

Figure 5: Prosodic strength and /s/ lengthening.



Bonferri Post-hoc tests confirm that significant differences are made between 1) 0~1b and 1c, 2) 1c~2b and 2c, and 3) 2c and 3 (at the 0.05 level). Of our particular interest is the durational behavior of /s/ depending on PoW. When PoW is the only positive prosodic factor (1b), the duration of /s/ does not differ from the /s/ durations either in the weakest context (0) or accented /s/ (1a). As a single prosodic factor, stress is the one that significantly lengthens the /s/ duration (1c). When the PoW feature is combined with accent (2a), the effect becomes visible and the amount of lengthening is equivalent to the effect of stress combined with accent effect (2b). Interestingly,

stress effects increase when the PoW factor is combined (2c), but the stress effect is still the greatest among the two-factor contexts (2a~2c). Finally the greatest lengthening occurs when PoW is combined with stress and accent (3 in Fig.5).

4. DICUSSION AND CONCLUSION

The results of the current study enable us to understand the nature of PoW effects and possible interplays between the PoW effect and other prominence effects (stress/accent). Firstly, the fact that lengthening of word-initial segment occurs only in the combination of other prosodic factors suggests that word-boundary effects may not be regulated in Spanish as an autonomous temporal modulation. Instead, it can better be characterized that stress and/or accent effects are enhanced word-initially. Secondly, prosodic effects are not simply cumulative in expressing prosodic strength. Certain prosodic effects may require relative strength of prosodic factor preserved in case of prosodic context changes. For instance, stress effects on the onset segment /s/ was the greatest in both weak positions (unaccented and/or word-medially) and strong positions (accented and/or word-initially), still expressing stress effects. This suggests that stress manifestation in this language requires phonetic prominence preservation and cannot be overridden by any other prosodic effects. Third, a cumulative behavior of prosodic effects is present between PoW and stress/accent effects, but not clearly so between stress and accent effects. The stress induced onset lengthening was independent of PoW or accent conditions, and was cumulative when combined with the PoW effect (i.e., 1a<2a<3, 1b<2b<3, 1c<2c<3, in Fig.5). This combinatory prosodic effect can best be characterized by identifying stress and accent as one kind (prominence effects) of prosodic effects, and PoW as another (boundary effect) [2, 4]. This joint effect between boundary and prominence factors is in line with previous studies for other language, e.g., [5].

The results of the current study provide an implication for future research on prosody. PoW effects can be conditioned by other prosodic effects (e.g., prominence factors) in one language (e.g., Spanish, see also [10]), but possibly not in others (e.g., non-stress/accent languages). In addition, prosody interactions may differ among languages such that different prosodies (stress, accent, and/or boundary) may constrain other prosody manifestation, depending on how such prosodies are relatively encoded in languages (e.g., accentuation may induce greater prominence than stress). Research on prosodic interactions deserves more attention in the future. It was emphasized in this study that interactions and interrelations among prosodic factors should be taken into consideration in understanding of the complex nature of prosody manifestation.

5. REFERENCES

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[1] (1) Word-initial /s/V: *sísalo/silicio, súbito/ sujeto, séquito/secado, sótano/sollozo, sádico/saludo,* (2) Word-medial /s/V: *risible/fósiles, desuso/cápsula, cosecha/díselo, pasota/ kósovo, bisagra/pésalo.*