

## On the reduction of V-to-C anticipatory labialization with age in adult speech

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One of the most frequently documented changes in adult speech with age is a slowing down of speaking and articulatory rate for older speakers ([1], [2], among many others; see [3] for a review). This slowing down has been explained by age-related physiological changes (for instance muscle weakening or reduced respiratory capacities) or by a decline in motor control and/or in other cognitive functions ([4]; [5], [2]). Recently, [6] have shown that anticipatory V-to-V coarticulation in French also reduces with age. More specifically, there is a gradual decrease in the amount of V-to-V anticipation for speakers from 20 to mid-50s, followed by a more abrupt decrease for speakers older than 70. Since a decrease in coarticulation (i.e., a decrease in overlap) results in longer segmental duration, one can wonder whether the change in coarticulation and rate at older age are the two side of the same coin. Yet, [6]'s results show that, while the relationship between the amount of coarticulation and the speakers' rate is strong for the younger speakers (with faster speakers coarticulating more), it is not for speakers over 70 y.o.a. The present study extends on this relationship between rate and coarticulation by at a smaller span of anticipation, i.e., anticipatory labialization within a CV syllable.

One hundred and twenty French speakers (half male, half female), aging from 20 to 90 years, have been recorded, reading a text in which we selected 24 monosyllabic words starting with /s/ followed by either the unrounded high front vowel /i/ or its rounded counterpart /y/ (i.e. 12 tokens of 'six' /sis/, *six* and 12 tokens of 'sud' /syd/, *south*). The [s] were segmented manually using Praat. Following the method of [7], a Praat script was used to record the duration of each [s], and over the 500Hz-15kHz frequency band, 12 spectra were calculated at 12 equidistant time points, with 25ms Hanning windows. Labialization of /s/ in [sy] is assessed in comparison to the [si] context with a measure capturing the lowering of the Center of Gravity and the Spectral Peak of the fricative on its central portion between 40% and 70% of the fricative duration. Speech rate is assessed both by an external measure of the speaker's articulation rate in another speech task (the reading of a small sentence) and by the acoustic segmental duration of /s/.

Based on the analysis of 40 speakers split into a younger speaker group (10 females & 10 males, 23-34 y.o.a, mean = 26.7 years) and an older speaker group (10 males & 10 females, 72-86 y.o.a, mean = 78.2 years), the following results are found. While anticipatory labialization is observed in both groups as a lowering of CoG/spectral peak in the [sy] context, anticipatory coarticulation is reduced in the older speakers group as compared to the younger speakers group. At an individual level, most speakers present a lowering of CoG/Spectral Peak in [sy] vs. [si], except 1 male and 4 female speakers, all over 76 y.o.a. (except a young one). As expected, a articulation slower rate and a longer /s/ duration are found in the older speaker group compared to the younger speaker group. More interestingly, as found for V-to-V anticipatory coarticulation by [6], the relationship between temporal aspects and the amount of anticipatory V-to-C labialization in our study is observed only in the younger speakers group. This is illustrated in Fig. 1 which shows a moderate positive coarticulation ( $r=.53$ ) between CoG and /s/ duration for the younger male groups but not for the older speaker group ( $r=.21$ ). Within this older group, /s/ are more or less labialized independent of their duration, and independent of the fact that the speaker is slow or fast.

These results confirm a nonlinear relationship between slowing down and reduced coarticulation in older age. We suggest that the reduced co-articulation observed both between (VtoV, [6]) and within syllables (VtoC, here), reflects a change in the parametrization of speech in the elderly which limits the overlap between articulatory gestures and ensures that successive articulatory targets are reached.



**Figure 1** Relationship between CoG in Bark measured in the central portion of the /s/ in the [s<sub>y</sub>] context and /s/ duration. While speakers in the young group (blue) show a moderate positive trend showing less CoG lowering (i.e., less anticipatory labialization) for longer /s/ ( $r=.53$ ), the lowering of CoG in the older speaker group is independent of /s/ duration.

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