Effect of age on rate and coarticulation across different speech-tasks

Daria D'Alessandro, Angélina Bourbon, Cécile Fougeron
Laboratoire de Phonétique et Phonologie (UMR7018, CNRS – Sorbonne Nouvelle, France)

While the effects of aging on speech rate are well known, unclear is the interaction between age, rate, articulatory precision and coarticulation, together with the influence of task on these aspects of speech. The current study aims at investigating the variation in rate and coarticulation depending on speakers' age group according to task demands.

BACKGROUND: Changes in some speech dimensions are expected with aging. The most documented change is a decrease in articulatory and/or speech rate for older speakers (e.g. [1]). However, reasons of this decrease are unclear. Several possible causes have been discussed in the literature: slowing down can be attributed to physiological changes (muscular, sensory or structural changes [e.g. 2]), to a decline in timing control mechanism [e.g. 3], and/or to a change in the planning of speech units (e.g. [4]). This latter account is suggested by the fact that older speakers also modify the coordination between successive syllables in a word, with a reduced amount of anticipatory coarticulation between vowels in a VpV word [5]. This reduction in VtoV coarticulation is linked, but is not strongly correlated, with a reduction of rate for the older group, calling for a better understanding of the relationship between speech rate and long distance coarticulation [6, 7]. While other studies suggest that older speaker groups differ in their strategy to modulate speech rate when required to, another aspect obscuring the picture is linked to the variety of production tasks (with more or less speech-like material and various way of manipulating speech rate) used in the literature [8, 9]. In the present study, three different speech-like tasks are used to investigate how two groups that differ in their speech address different speech conditions.

MATERIAL AND METHODS: We recorded 27 French speakers aged between 23 and 90 years, divided into two age groups: a 'Younger' group (13 speakers, 7F/6M, aged 23<>54 years, M = 34.23 (±7.99)), and an 'Older' group (14 speakers, 12 F/2M, aged 68<>90 years M = 80.71 (±5.92)). Three tasks were performed by the subjects in a single session: the reading of the sentences of a story (*Reading*), and two repetition tasks, where a short meaningful French sentence ('*Papa et Papi papotaient constamment*') was to be continuously repeated during 15 seconds, first, as fast as possible while remaining as accurate as possible (*RepetMax*), then, at a self-determined comfortable rate (*RepetComfo*). Anticipatory VtoV coarticulation was tested on /a/ according to V2 /a/ or /i/ in disyllabic /papV2/ French words. We analysed: a) articulation rate, i.e. the number of syllable per sentence computed over each sentence duration (excl. pauses); b) an index of articulatory precision corresponding to the acoustic F1 target of V1 /a/, in /papa/; c) a measure of Acoustic Assimilation, defined as the difference in F2/F1 compacity between /a/s in V2 /i/ context and the following /i/, divided by /i/ for each item. The higher the Acoustic Assimilation, the greater the coarticulation degree.

RESULTS AND DISCUSSION: As expected, Older speakers are found to speak slower than Younger speakers, and this difference is more striking in the repetition tasks than in the *Reading* task (see Fig.1a). Nevertheless, the two groups present the same degree of acceleration ($\frac{RateRepetMax-RateRepetComfo}{RateRepetComfo}$=*0.4* for both groups). A difference between groups is also found in the trade-off between target achievement and speed. Younger speakers reduce F1 in both repetition tasks, whereas Older speakers do it only in *RepetMax* task (Fig. 1b). This lowering of F1, interpretable as vowel reduction, is indeed expected if target undershoot is done to achieve a faster speech rate. However, the Younger group adopts this strategy also at a comfortable rate, probably as a way to optimize repetition performance of the numerous /pVpVpV/ syllables of the sentence by blocking their jaw. As for V-to-V coarticulation, both groups present similar degrees of coarticulation in the Reading. However, Younger speakers present greater coarticulation degree in the repetition tasks compared to the *Reading*, with *RepetMax* presenting the maximum of coarticulation. Conversely, Older speakers present a similar degree of coarticulation in the repetition tasks compared to the *Reading*. A moderate

correlation is shown between rate and coarticulation, meaning that an increasing in rate in the repetition tasks only cannot entirely explain an increasing in coarticulation for Younger speakers. Taken together, these results support the fact that repetition tasks involve different control strategies than read speech [8, 9, 10], which is evidenced by the way the two age groups adapt to specific task demands.

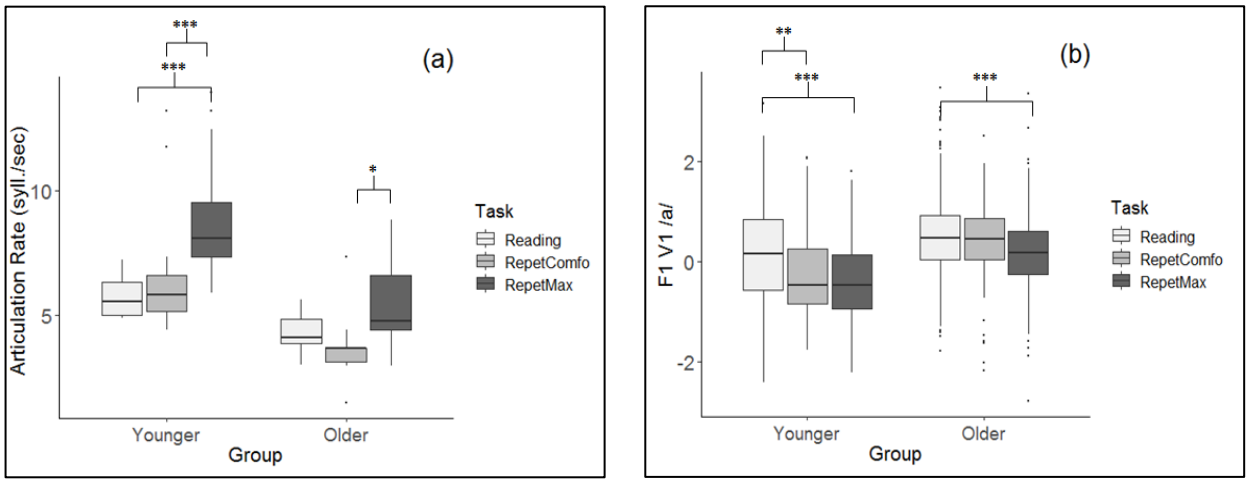

Figure 1: (a) Articulation rate and (b) F1 in z-score of /a/ in V2/a/ context, according to speaker group and to task condition.

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