Have a break: Aging effects on sentence production and structuring in French

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Motivation: Speech research mostly excludes the aged population. While there exists lots of research in language acquisition on the development of linguistic structure, there is a lack of research on language attrition. The behaviour of the speech system in the aged population will provide insights into how linguistic structures are realized on different phonological and prosodic tiers, when the physical system is challenged. Incorporating age-related speech allows us to cover repair mechanisms and adaptation to changes of the speech system. In this study, we investigate the effects of aging on durational parameters related to sentence structuring, depending on sentence length and complexity. The results provide evidence that (i) all age groups produced phrasal breaks at expected syntactic boundaries, with durations that were sensitive to sentence structure. Furthermore, (ii) we observed an age effect in that older speakers produced much longer pauses, longer sentence durations and lower articulation rates across all structures than the younger speakers.

Method: 27 French subjects (18f, 9m) were recorded acoustically and grouped into 'younger' (14 subjects, 23-44 years, mean 34 ± 8.01) and 'older' group (13 subjects, 68-88 years, mean 80 ± 5.53). All subjects had a normal or corrected-to-normal vision and cognitive level was controlled using assessments. Speech material consisted of sentences (based on [1]; cf. example in table), varying in complexity (simple vs. complex) and length (short vs. long). For each condition, we designed 3 different versions. Further, each sentence was repeated three times, i.e. 36 sentences per speaker. Annotations were done manually in Praat [2], segmentation of pauses was done by visual and audible inspection (pauses <100ms were discarded). We analysed: (a) NUMBER OF PAUSES, marked as breaks produced at comma-indicated boundary; (b) PAUSE DURATION; (c) ARTICULATION RATE, number of syllables divided by total time (excl. pauses); and whole (d) SENTENCE DURATION (incl. pauses).

Mélanie Dupont a réservé ses vacances. *(Mélanie Dupont booked her holidays.)*	short-simple
Mélanie Dupont, qui adore le soleil, a réservé ses vacances. *(Mélanie Dupont, who loves the sun, booked her holidays.)*	short-complex
Mélanie Dupont a réservé lors d'un froid jour d'hiver ses vacances en Andalousie. *(Mélanie Dupont booked her holidays in Andalusia on a cold winter's day.)*	long-simple
Mélanie Dupont a dit à sa mère, qui l'a appelée dans la matinée, qu'elle attend avec impatience ses vacances. *(Melanie Dupont told her mother, who called her in the morning, she's looking forward to her vacation.)*	long-complex

Results: NUMBER OF PAUSES: Both age groups produced pauses at expected, comma-indicated boundaries. Thus, simple sentences were marked with fewer pauses (young: short=11/long=15; old: short=16/long=71) than complex sentences (young: short=103/long=162; old: short=122/long=164). Especially in long-simple and short-complex condition older subjects produced much more pauses. PAUSE DURATION (Fig. 1A): pauses were longest in long-complex sentences for both age groups (e.g. pause at first comma: young: short-complex=171ms vs long-complex=228ms; old: short-complex=308 vs long-complex=420). Additionally, all pause durations were much longer for older than for younger speakers (on average 120ms longer). ARTICULATION RATE (Fig. 1B): speakers with the slowest articulation rate were those who also produced the longest pauses, i.e. the older group. This aging effect was visible in all conditions. There was no effect of sentence structure (complexity/length) on articulation rates. SENTENCE DURATION (Fig. 1C): the longer and complex a sentence, the longer its duration, with age even more affecting it (in line with what has been observed before). Furthermore, we observed a higher variability for the older speakers.

Discussion/Conclusion: This study applied different durational acoustic parameters to shed light on the effect of structure (length and complexity) and age on sentence production and

structuring. We were able to provide preliminary evidence that both length and complexity do affect durational patterns in younger and older speakers, e.g. with longest durations in long-complex sentences (increase in cognitive demands, cf. [3]). The factor age entailed an additional increase in duration (of e.g. whole sentences, and also pause duration). The lower articulation rate for older speakers is in line with the most robust (and reported) age-related effect (e.g. [4]). This slowing down could inter alia be explained as a mechanism to make sure reaching the targets properly [5]. Furthermore, it has been reported that across life span there is a change in respiration in that with increasing age, the ribcage cannot expand and contract as well during breathing and the diaphragm becomes weakened [6]. This physiological age-related change is expected to affect the control of breathing and thus also sentence production and structuring. Evidence has been provided that breathing in older subjects revealed higher lung volume to initiate speech, longer sentences are split into smaller units with less breathing at larger units and more breathing at smaller units [7,8]. Our results further point towards an age-related increase in duration variability which has been reported before [9,10].

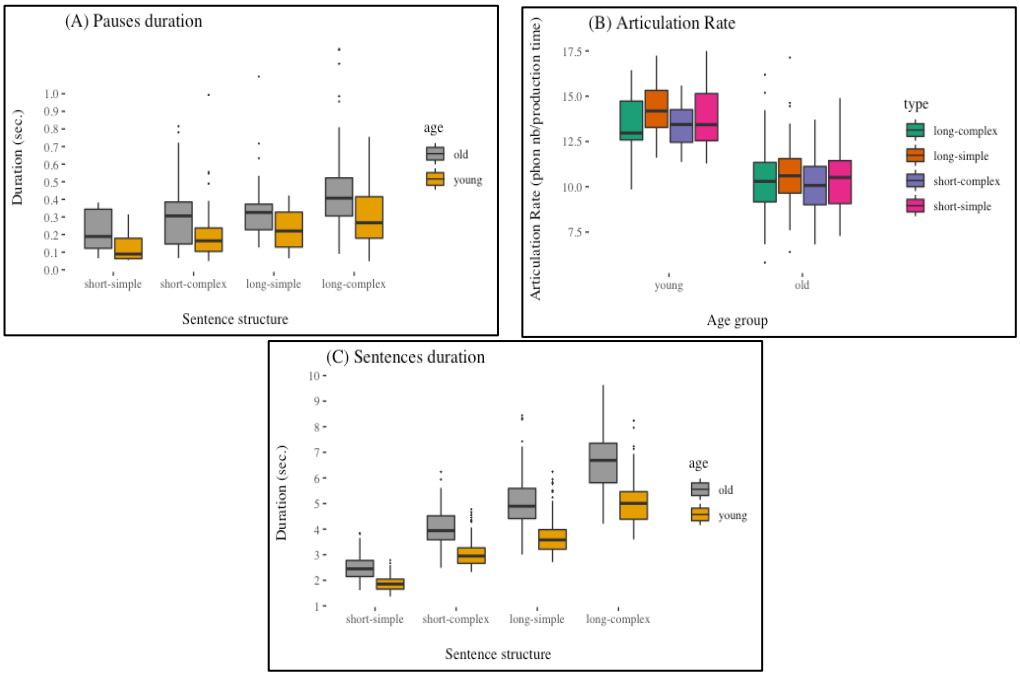

Figure 1: Results for (A) PAUSE DURATION, (B) ARTICULATION RATE and (C) SENTENCE DURATION across age group and sentence structure.

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