

Aging, Speech Rate, and Rhythmic Segmentation: Cognitive Constraints on Speech Comprehension

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1. State of art

Healthy aging and speech comprehension

- Healthy aging is associated with spoken language comprehension difficulties, amplified at faster speech rates (Wingfield et al., 2003; Kim & Ho, 2013)
- These difficulties are partly cognitive in origin, linked to verbal working memory (vWM) decline in older adults (Dede et al., 2004; Criscuolo et al., 2025)
- Reduced vWM capacity limits the ability to maintain and process linguistic information under increased cognitive load (Caplan & DeDe, 2011)

Rhythmic segmentation and cognitive chunking

- Speech is segmented into accent phrases (APs), each closed by a final stressed syllable acting as a rhythmic cue (Martin, 2018)
- Delta oscillations (~1 Hz) track prosodic boundaries enabling chunk-by-chunk processing (Gilbert, 2012)

2. Hypothesis

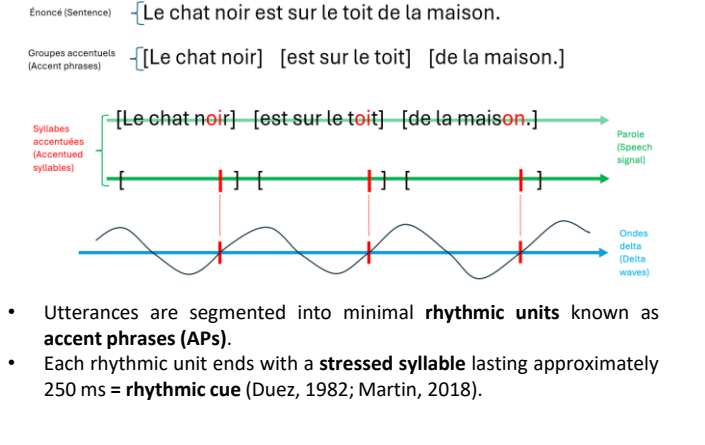
R.Q : At accelerated speech rates, this temporal decoding is disrupted, increasing cognitive load and reducing comprehension.

Hypothesis 1: The increase in speech rate leads to a deterioration in comprehension performance in the older group.

Hypothesis 2: The increase in speech rate leads to a deterioration in repetition performance in the older group.

Hypothesis 3: Cognitive abilities — working memory & rhythmic perception — predict performance in comprehension and repetition abilities.

3. Acoustic landmarks, rhythmic cues and accent phrases



4. Complete protocol

General timeline

- Control task (CT)
- EEG measurement
- Comprehension task
- Repetition task

Focus on comprehension & repetition tasks (post EEG)

1. Participant listen a sentence N = 30 sentences n = 10 / SR condition

2. Participant answers to a question about the sentence (subject, adj., verb) n = 15 of 30, pseudo randomized

3. Repeat the sentence N = 30

If good : Go to the next sentence ✓
If not good : Retry repetition until success or failure (5 attempts) ✗

T1. Table of question's scoring (bimodal score)

Good answer at 1st attempt	1 point
Wrong answer at 1st attempt	0 point

Fail to answer well at the question does not lead to a second (or more) attempts. Final score is converted in percent of good answers given for each participant.

T2. Table of repetition's scoring (continue score)

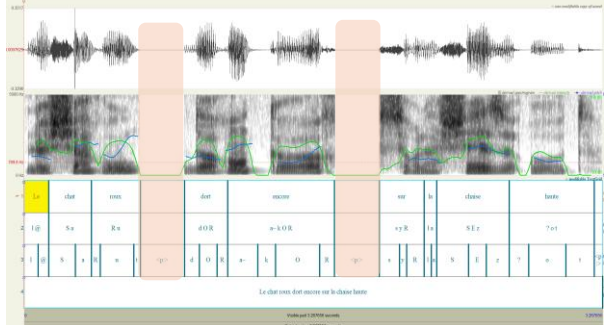
1st attempt	1 point
2nd attempt	0,8 point
3rd attempt	0,6 point
4th attempt	0,4 point
5th attempt	0,2 point
Still incorrect after 5 attempts	0 point

Stimuli

A total of 150 declarative sentences in French. → 50 sentences presented in three speech rate (SR) conditions :

- Neutral speech rate (SRN) (n = 50) (~4 syll/s)
- Accelerated speech rate x2 (SRA) (n = 50)
- Accelerated speech rate x3 (SRA+) (n = 50)

All sentences are emotionally neutral and produced by a male speaker. Each sentence contain three accentual phrases in the neutral speech-rate condition. Inter-accentual-phrase pauses are normalized to 250 ms in the neutral speech-rate condition. All modifications are made with Praat (Boersma & Paul, 2001)

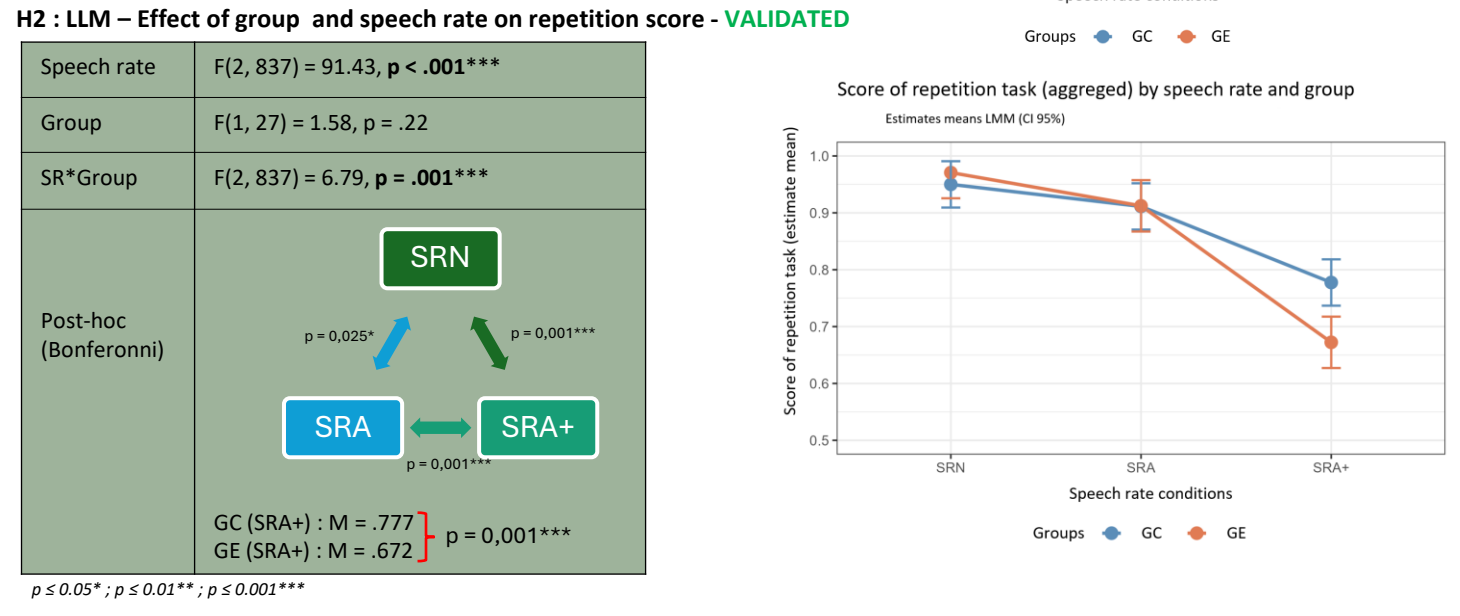
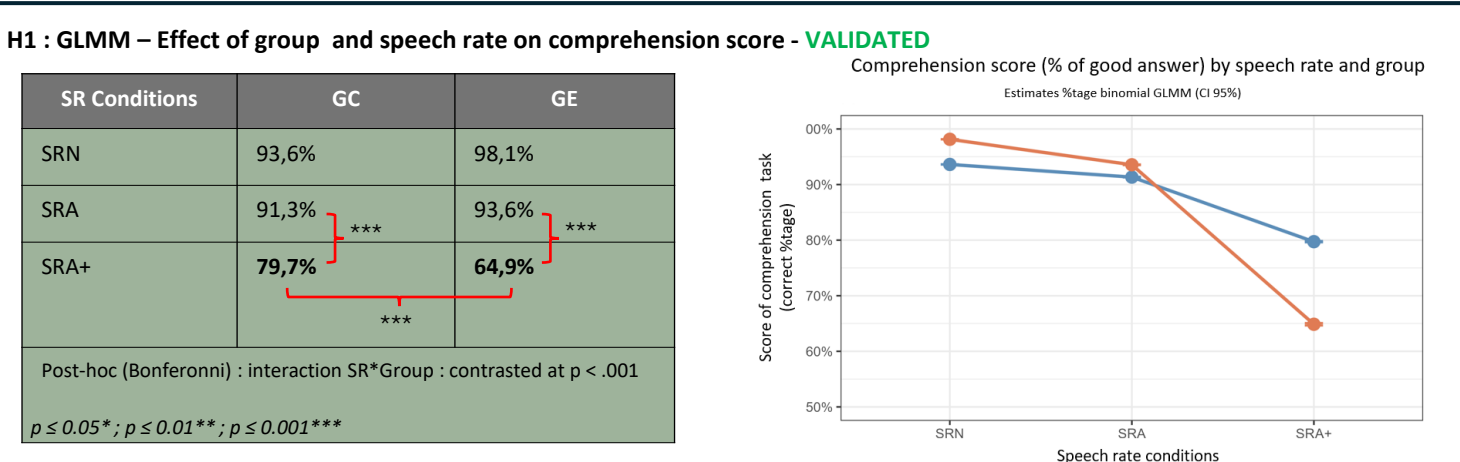


Sample

Control group (GC)	Experimental Group (GE)*
Healthy young people (20 – 28y)	Healthy older people (52 – 69y)
n = 17 (13F)	n = 13 (6F)
Age mean = 22.6 y (±2.6y)	Age mean = 57.8 y (±4.7y)

*Because of the lack of participants in the 3 groups of healthy elders (50-59, 60-69, 70-79 years), we regroup all participant in one group (GE)

5. Analyses and results



H3 : Correlations of scores and cognitive control tasks – NOT VALIDATED

	vWM	MBEA1	MBEA2
Compr_scores*CT	GC : rho = 0.155, p = 0.02* GE : rho = 0.136, p = 0.08	GC : rho = 0.125, p = 0.05 GE : rho = -0.073, p = 0.35	GC : rho = -0.045, p = 0.49 GE : rho = -0.021, p = 0.79
Repet_scores*CT	GC : rho = -0.007, p = 0.98 GE : rho = 0.120, p = 0.7	GC : rho = -0.104, p = 0.69 GE : rho = -0.270, p = 0.37	GC : rho = -0.007, p = 0.98 GE : rho = -0.434, p = 0.14

p ≤ 0.05* ; p ≤ 0.01** ; p ≤ 0.001***

6. Conclusion

H1 & H2 are mainly accepted. Repetition and comprehension scores are both affected by a significant interaction between speech rate and group. At the highest speech rate (SRA+), older adults (GE) show a steeper decline than younger adults (GC) in both tasks — repetition: GE (M = .672) vs. GC (M = .777); comprehension: GE (64.9%) vs. GC (79.7%).

H3 is rejected. Cognitive abilities (vWM, MBEA1, MBEA2) did not predict comprehension or repetition performance in either group. The only marginal result concerned vWM and comprehension in younger adults (rho = 0.155, p = .02). This suggests that speech rate adaptation may rely more on automatic perceptual mechanisms than on higher-level cognitive resources.

Limitations

- Size of groups (n < 30)
- vWM is not deeply investigate (more tasks needed)
- MBEA is a music based battery, no spoken stimuli

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