Aging effects on task-based activity and functional networks during semantic processing and rest

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Introduction

- Most cognitive control functions such as working memory and processing speed decline with age [1]
- Semantic memory however – the conceptual knowledge acquired across life – remains stable [2]
- Still, older adults are slower and worse at retrieving words, resolving semantic conflicts, and inhibiting irrelevant information [3]
- This suggests that the age-related cognitive decline also affects semantic control processes

Research questions

How does cognitive aging modulate the interaction of cognitive control and semantic networks in the brain?

How is this mirrored in functional connectivity profiles during task and rest?

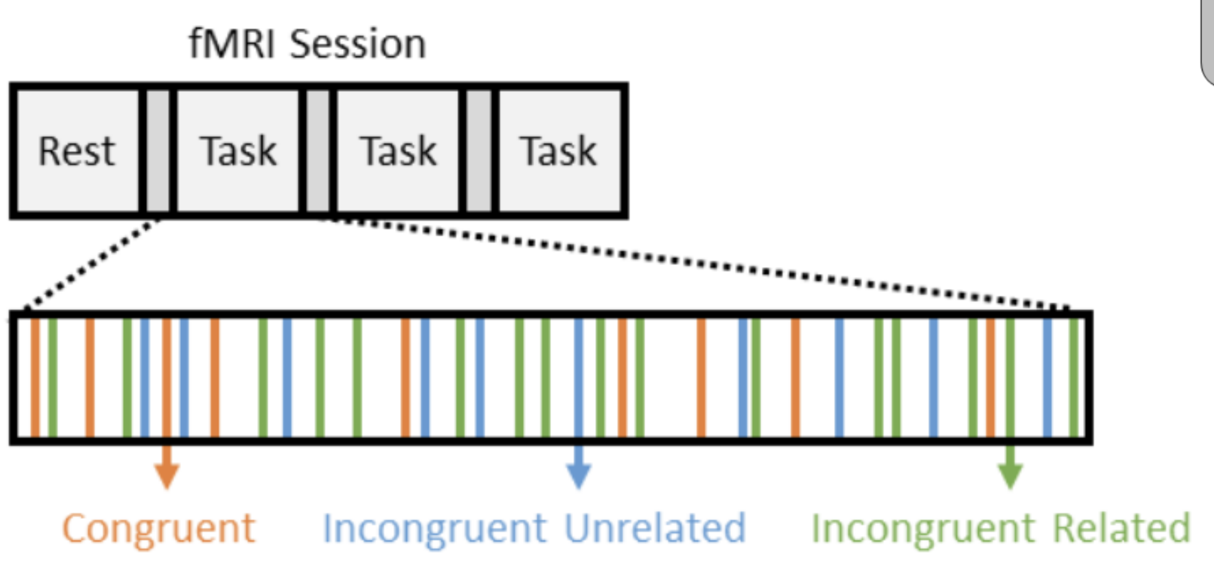
Methods

Participants

- 41 older adults (M 66, SD 3.17, 60-70 years)
- 43 young adults (M 28, SD 4.3, 21-35 years)

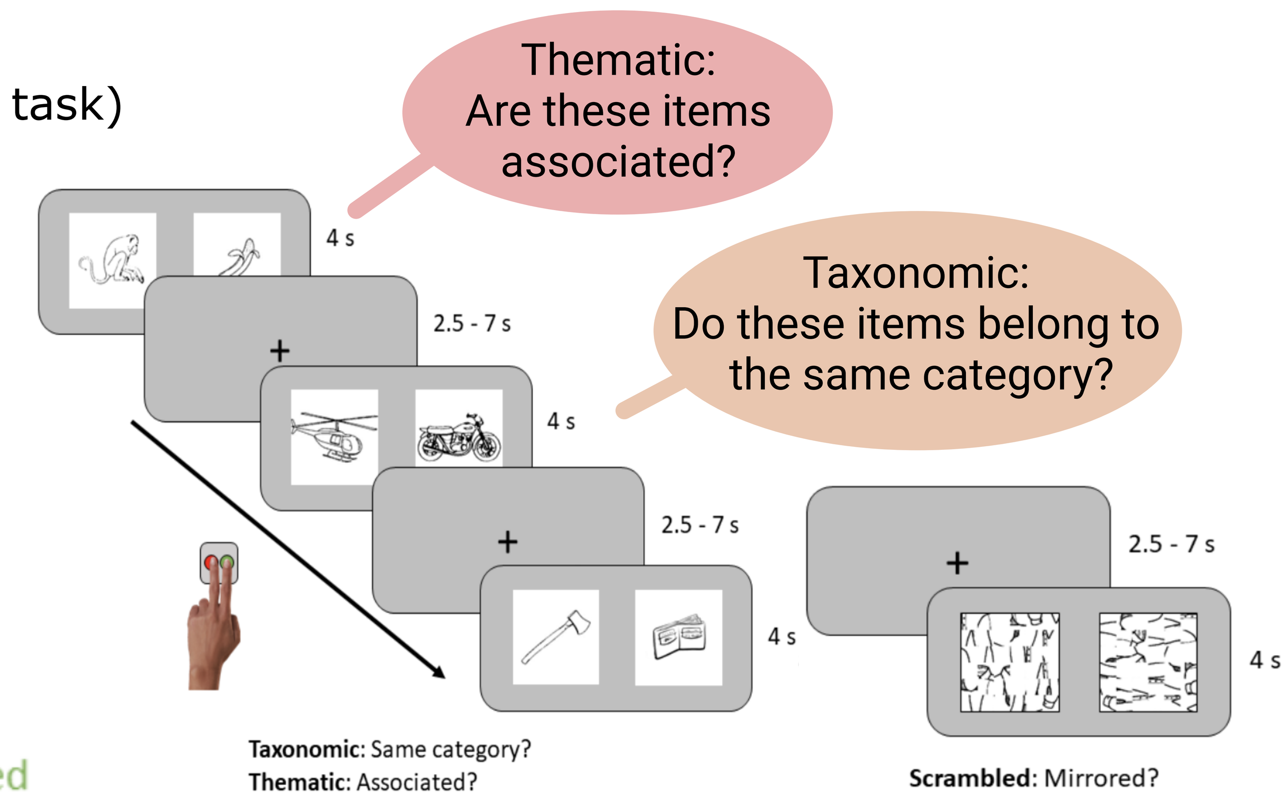
Study Design

- One fMRI session (~ 60 min)
- One run of each task (thematic, taxonomic, control task)
- One run of resting-state fMRI



Experimental Design

- Semantic judgment task: taxonomic & thematic relations
- Three conditions per semantic task: congruent, incongruent unrelated, incongruent related
- Control task with scrambled pictures

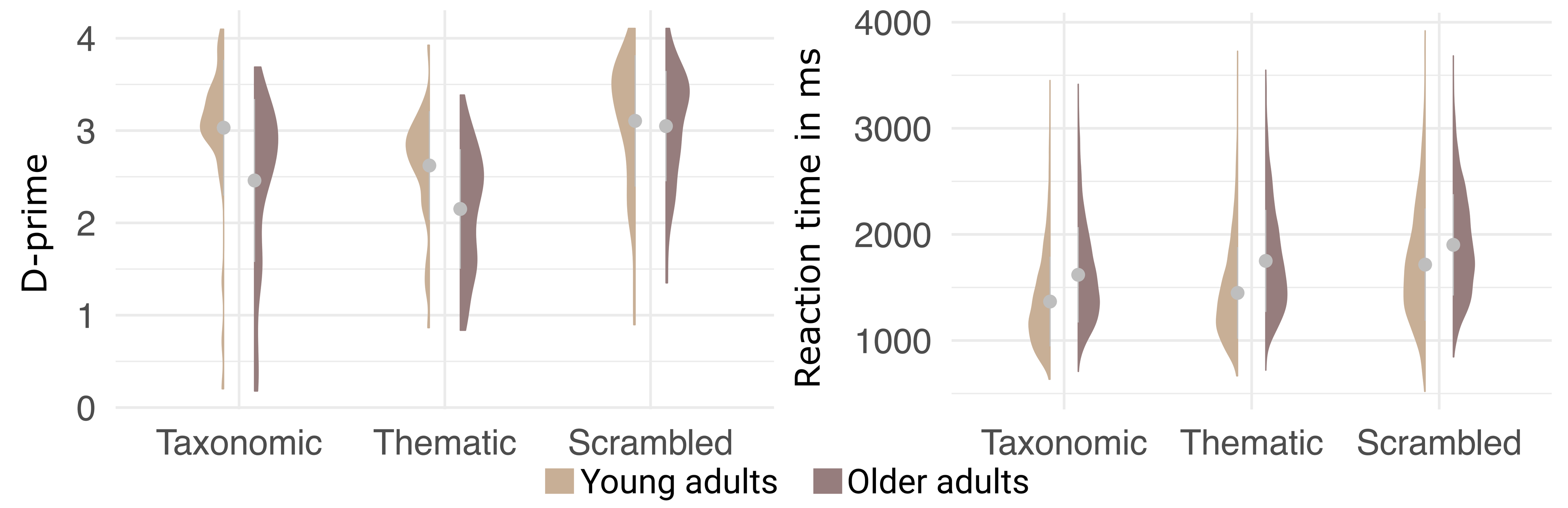


Results

Data Analysis

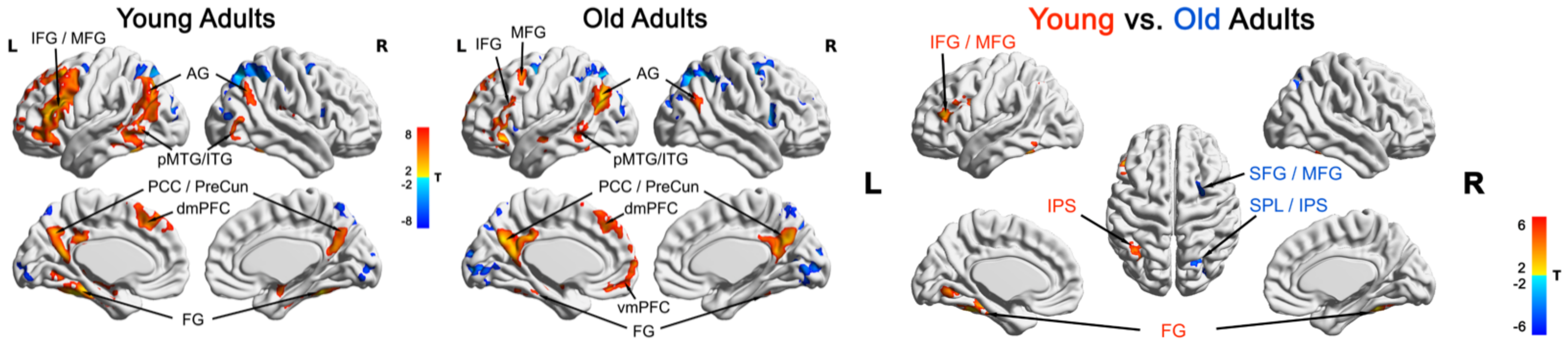
- Behavioral data anaylsis using mixed-effects models
- Preprocessing of fMRI data with fMRIPrep 22.3 [4]
- Univariate analyses in SPM12
- Functional connectivity (FC) analyses via timeseries extraction for 400 parcels (Schaefer, 2018) for each run
- Simultaneous denoising via nilearn (incl. WM, CSF, FD, Motion)
- FC matrices for semantic tasks (taxonomic + thematic) were correlated with FC matrices of rest
- Age comparison of correlations via t-test

Behavioral Results: Older adults are slower and less accurate in all tasks

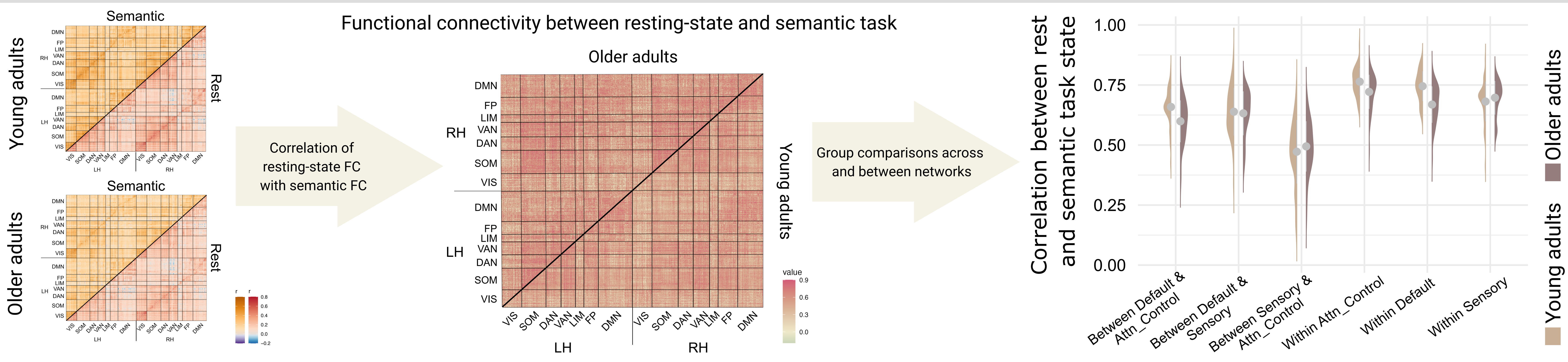


Univariate fMRI Results: Semantic > Scrambled Task

Semantic task activates key regions of cognitive control and semantic control. Aging increases activity in right hemisphere.



Functional connectivity during rest and semantic processing are highly correlated. Young adults show stronger correlation between both states than older adults.



Discussion

- Older adults perform generally slower and poorer across all semantic tasks and the control task
- Both age groups show **semantic-related activity** in key regions of **domain-general and semantic control**
- **Older adults** show more **activity** in **domain-general regions in right hemisphere**, **young adults** in **left-lateralised semantic control**
- **FC during resting state and semantic processing** is **positively correlated** in both age groups, albeit **stronger in young adults**, especially in attention and control networks
- Stronger **synchronization between rest and task state** in young adults is accompanied by **better behavior** – underlining similarity between brain states during resting state and semantic cognition

References

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[4] Esteban, O., et al. (2019). Nature Methods, 16: 111-1116.

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