White matter microstructure associated with functional connectivity changes following short-term learning of a visuomotor sequence

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INTRODUCTION

- Efficient neural transmission is crucial for optimal brain function.
- Motor sequence learning (MSL) = window into how the brain can be reshaped through learning.
- Different neural circuits are involved at each stage of motor learning. [1,2]
- Few studies investigating white matter (WM) plasticity have characterized stage-specific changes in microstructure.

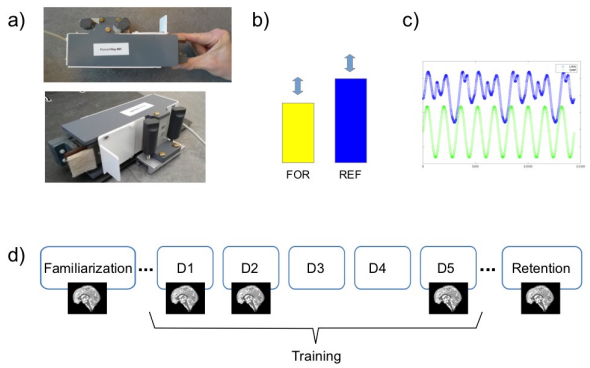
OBJECTIVES

- Investigate short-term changes in WM and the temporal dynamics across learning stages.
- Investigate the relationship between WM plasticity and changes in functional connectivity.

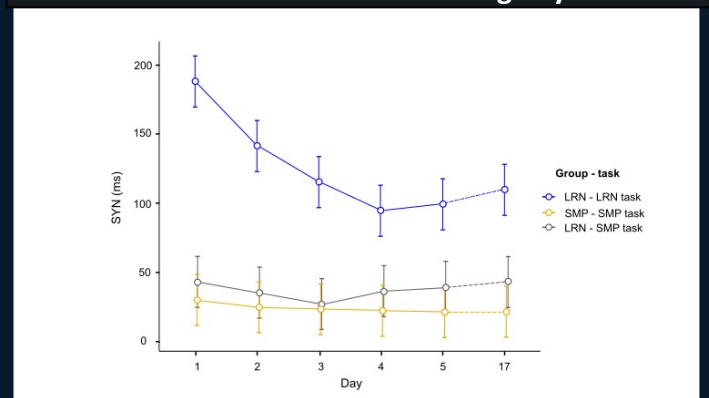
METHODS

- Siemens 7 Tesla MRI scanner used for acquisitions.
- 40 young healthy subjects (age: 24.5 ± 2.44 y.o.; females: 21).
- Sequential Pinch Force Task (SPFT): 5 consecutive training days; inside the scanner on d1, d2, d5 and at retention session.
- LRN group: complex sequence (in blue).
- SMP group: simple sequence (in green).

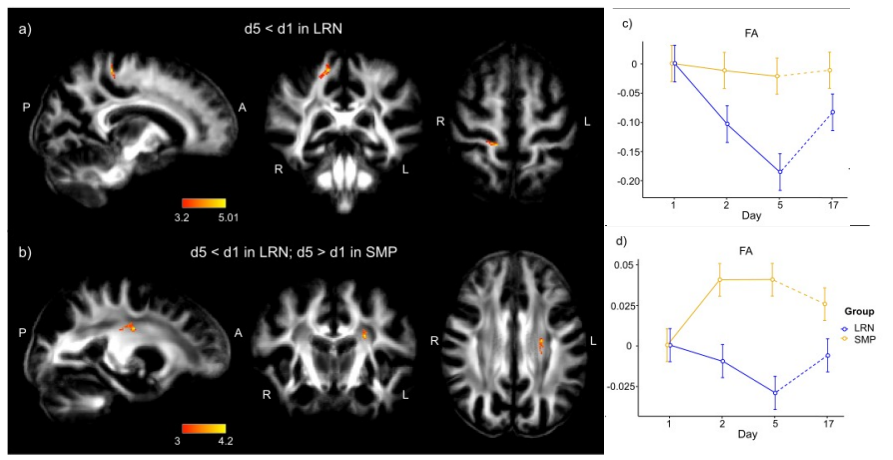
Sequential Pinch Force Task and study design



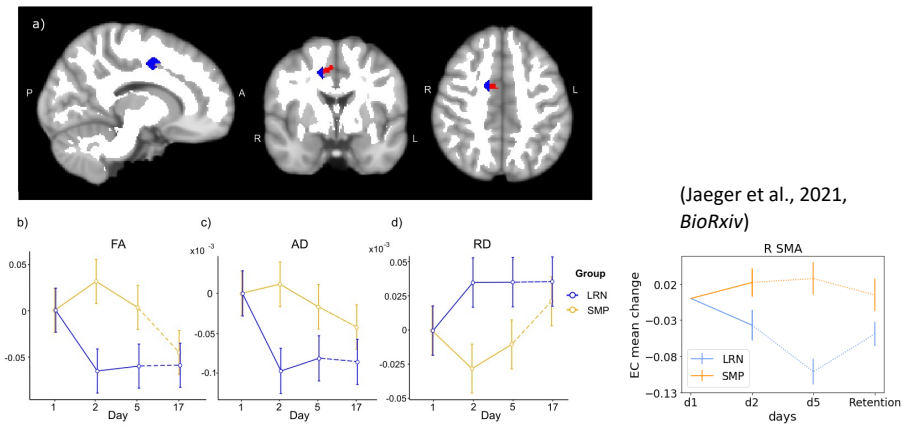
Performance across training days



Changes in white matter in the LRN group



Structural and Functional Changes in the SMA



(Jaeger et al., 2021, *BioRxiv*)

DISCUSSION

- Decreased FA in fiber tracts connecting to the right S1
  => suppression S1 ipsilateral to the hand used in the task
  => enhance processing of task-relevant inputs by the contralateral S1.[3,4]
- Slow decrease in FA in LRNs in fiber tracts connecting to the left M1
  => activity in M1 progressively decreases as motor learning progresses, perhaps reflecting enhanced network efficiency. [1,5,6]
- Decreases in FA and AD in the SMA, and decreased functional connectivity in this region, known for its role in sequence processing
  => reduced need for resources to plan and coordinate movements as a skill is mastered. [7]

CONCLUSION

Together, our findings provide evidence for **highly dynamic** WM plasticity in the **sensorimotor network** during short-term MSL, where the **SMA** would play a key role in linking the spatial and motor aspects of motor sequence learning. [1,,8]

Interestingly, the changes in WM microstructure preceded the functional changes in connectivity that were found in the same cohort, indicating a potential **link between structural and functional plastic processes**.

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