# Self-Similar Properties of the rs-fMRI Signal Reflect Functional Changes in Neuroplasticity Following Motor Sequence Learning.

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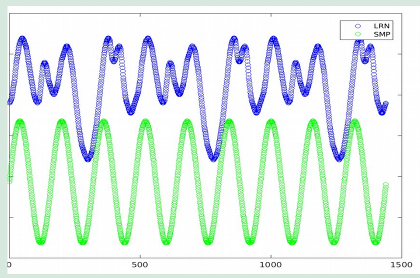
## Introduction

- Recent research shows functional relevance of self-similarity in rs-fMRI signal in health and disease [1,2]
- **Self-similarity carries information about signal changes over time so can it also reflect functional neuroplasticity?**
- We measured self-similarity using the Hurst Exponent (HE) in rsfMRI data during complex motor sequence learning
- We investigated whether HE changes meaningfully reflect functional changes following motor sequence learning, their relationship to behavioral performance as well as the recovery of HE to pre-training levels [3]

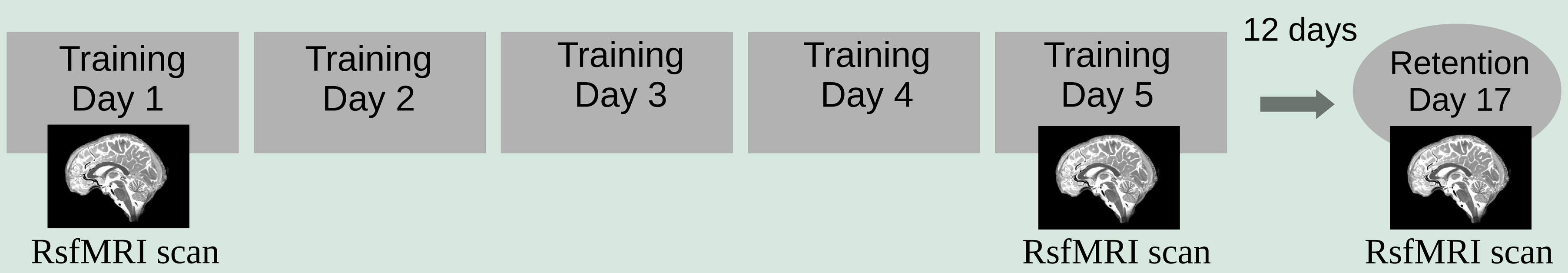
## Methods

**Experimental Design**

Task : Sequential Pinch Force Task



Experimental Sequence
Control Sequence

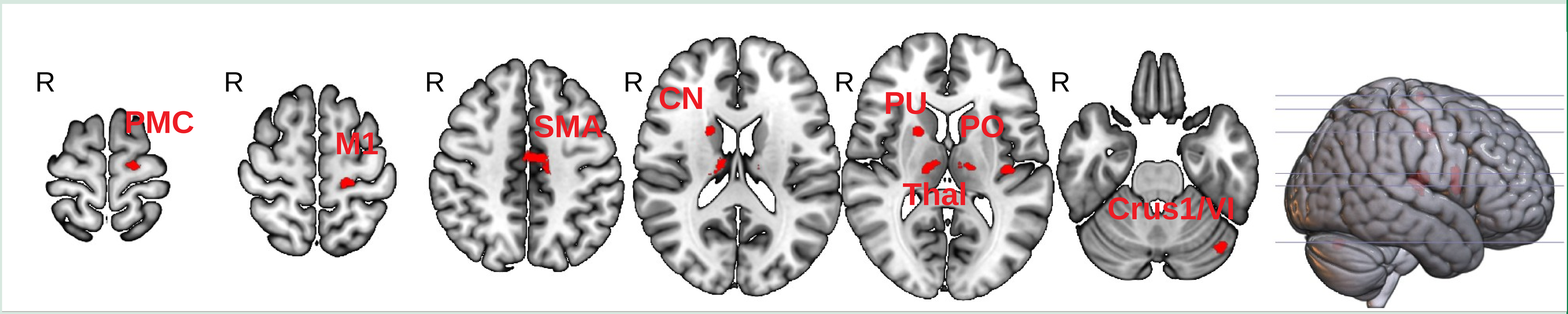



- Two groups, Two Sequences: complex learned sequence (LRN) & Simple sequence (SMP); Training: 5 consecutive days & again after 12 days
- Behavioral measure = temporal accuracy / Synchrony (SYN)
- Whole brain HE maps were computed via Detrended Fluctuation Analysis [4] (window range: 15-55)
- Sequence-specific effects were identified with a 2x2 (group x time) flexible factorial interaction analysis
- Behavioral relevance of HE was investigated with correlation analyses between the identified ROIs and behavioral performance (SYN)
- HE recovery rates were investigated by applying paired samples t-tests between Day 1(d1)/Day 5(d5) and Day 5(d5)/Day 17(d17)

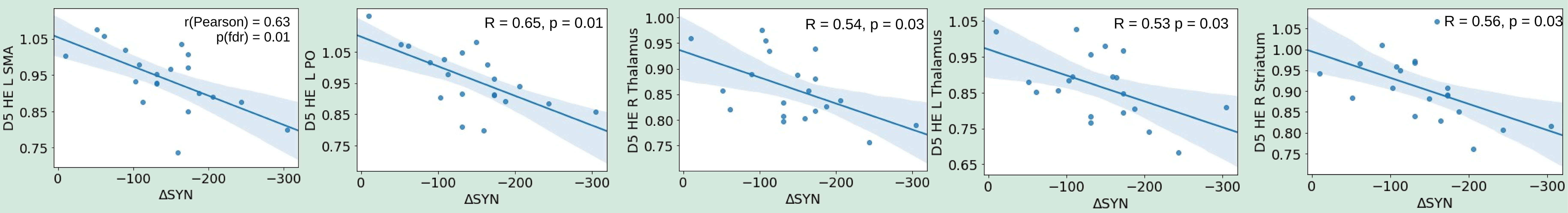
## Results

**Interaction effects:** HE Decreases in exp. group between d1 and d5.

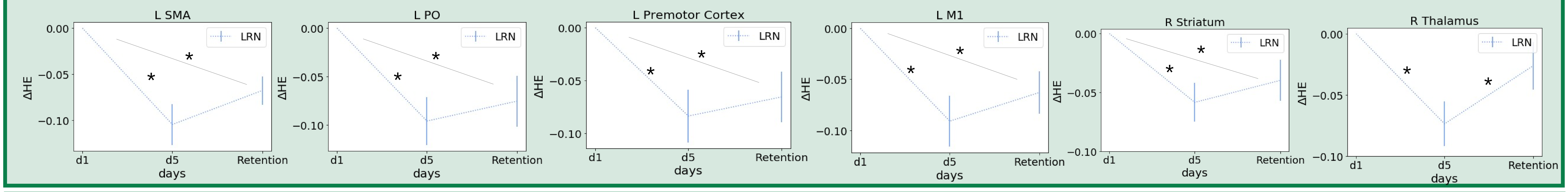
PMC = premotor cortex, SMA = supplementary motor area, PO = Pars Opercularis, CN = Caudate Nucleus, PU = Putamen, Thal = Thalamus




**Correlations:** 5 clusters showed negative correlations between performance increase (SYN) and HE on d5; d5 HE values in left PMC, left M1 and left cerebellar H IV/Crus 1 were not correlated to d5 SYN




**HE Recovery**: Paired samples t-tests in LRN HE ROIs between d5/d17 & d1/d17. Cerebellum and left thalamus showed no significant difference between d5/d17 or d1/d17




## Discussion

- We confirm that decreases in HE reflect task-specific functional neuroplastic changes
  - namely sequence-specific changes in well-known motor sequence learing associated areas including SMA, PMC & M1 [5, 6, 7, 8]
- Correlation of HE decrease with performance indicates behavioral relevance
- Longitudinal analysis suggests different patterns of HE change and recovery across the brain
- Future research needs to determine the applicability of HE changes as a biomarker for neuroplastic changes e.g. in rehabiliation research

**References:** **[1] Campbell** et al., 2022, https://doi.org/10.1002/hbm.25801; **[2] He**, 2011, https://doi.org/10.1523/JNEUROSCI.2111-11.2011; **[3] Barnes** et al., 2009, https://doi.org/10.1371/journal.pone.0006626; **[4] Hardstone** et al, 2012, https://doi.org/10.3389/fphys.2012.00450; **[5] Krakauer** et al., 2019, https://doi.org/10.1002/cphy.c170043; **[6] Dayan & Cohen**, 2011, https://doi.org/10.1016/j.neuron.2011.10.008; **[7] Jäger** et al, 2021, https://doi.org/10.1007/s00429-021-02412-7; **[8] Yokoi & Diedrichsen**, 2019, https://doi.org/10.1016/j.neuron.2019.06.017