

Decreased Self-Similarity of the rsfMRI BOLD Signal reflects Motor Sequence Learning Up to Two Weeks following Training.

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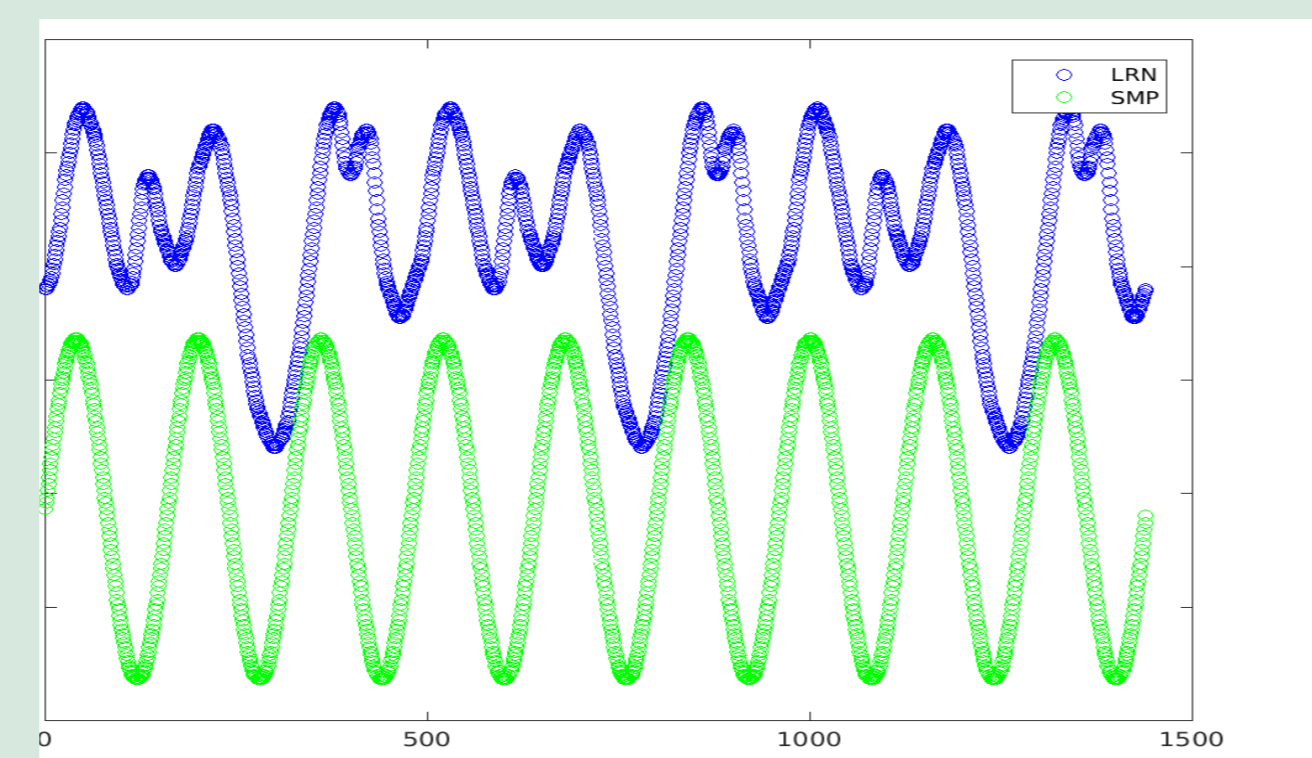
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Introduction

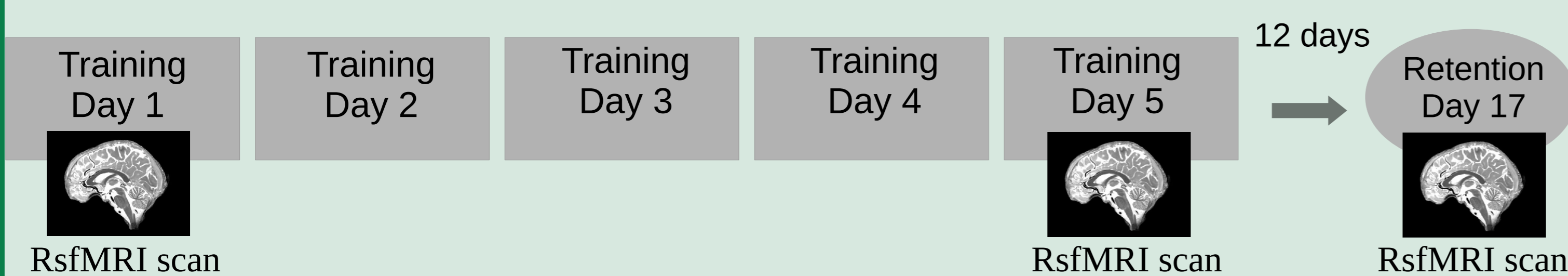
- Self-similarity of brain signal decreases during cognitive effort [1] and increases during rest [2,3], as reflected by changes in the Hurst Exponent (HE)
- **We investigated whether functional neuroplastic changes in the rsfMRI signal following motor sequence learning are reflected by HE changes, their relationship to behavioral performance, and the recovery of HE to pre-training levels [1].**

Methods

Task : Sequential Pinch Force Task



Experimental Design



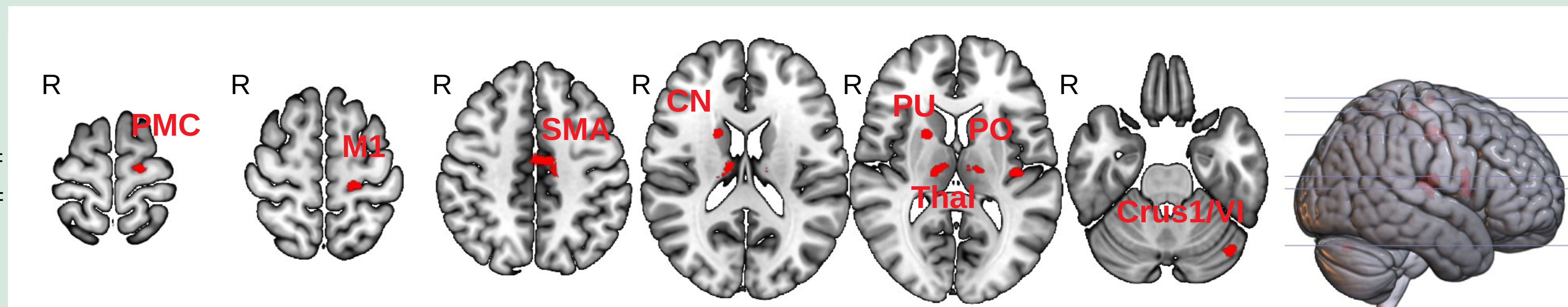
- Two groups, Two Sequences: complex learned sequence (LRN) & Simple sequence (SMP); Training: 5 consecutive days & again after 12 days
- Behavioral measure = temporal accuracy / Synchrony (SYN)
- Whole brain HE maps were computed via Detrended Fluctuation Analysis [4] (window range: 15-55)
- Sequence-specific 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

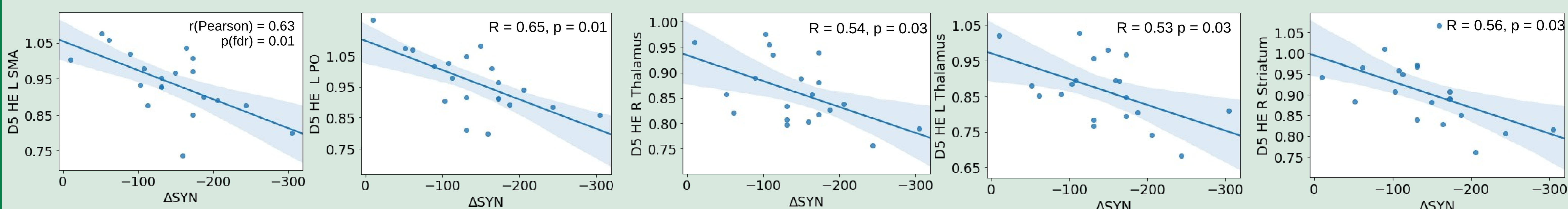
Interaction effects: HE

Decreases in exp. group between d1 and d5.

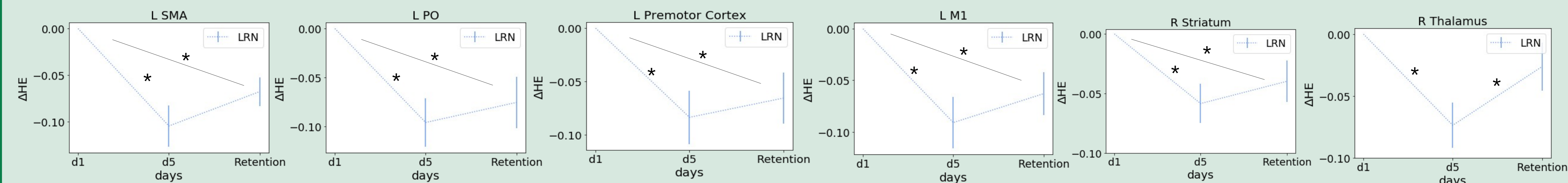
PMC = premotor cortex, SMA = supplementary motor area, PO = Pars Opercularis, CN = Caudate Nucleus, PU = Putamen, Thal = Thalamus



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 show that decreases in HE during rest reflect task-specific functional neuroplastic changes
 - namely sequence-specific changes in well-known motor sequence learning associated areas including SMA, PMC & M1 [5, 6, 7, 8]
- Correlation of HE decrease post-training with performance indicates behavioral relevance
- Longitudinal analysis suggests lasting decrease of HE in some task-relevant regions
- Future research needs to determine the applicability of HE changes as a biomarker for neuroplastic changes e.g. in rehabilitation research

References: [1] Barnes et al., 2009, <https://doi.org/10.1371/journal.pone.0006626>; [2] Churchill et al., 2016, <https://doi.org/10.1038/srep30895>. [3] Nikulin et al., 2004 <https://doi.org/10.1016/j.clinph.2004.03.019>. [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>