# Reorganization of cortical motor representations after long term sequential skill learning

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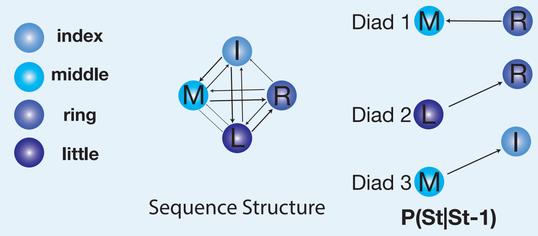
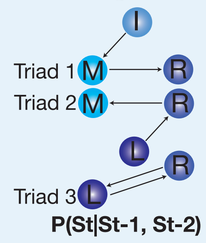
## Background

• Learning complex sequential skills requires binding multiple responses into a single unified action (Rosenbaum et. al 1983)

• **Hypothesis**: Binding should increase temporal correlations in movements and reduce representational distances in sensorimotor networks.



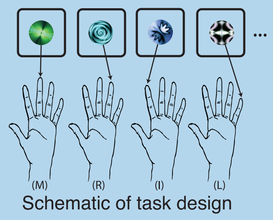

## Theory




Training binds representations of downstream effectors resulting in correlated responses (Verstynen et. al. 2012)

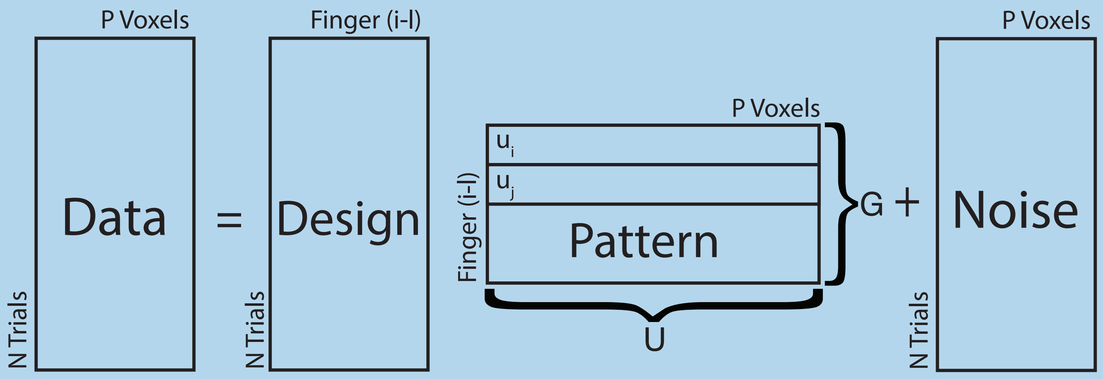
## Methods

- Participants: Neurologically healthy adults (n=18, 9 control, age = 21-37, 6 female)
- Training: 5 weeks, 800 sequence trials & 600 random trials per training session
- Sequence (N=9): Indirectly cued, 32 items (8 movements per finger)
- Control (N=9): No sequence structure during training
- Reaction time (z-units) $= \frac{\mu_{Random} - \mu_{Sequence}}{\sigma_{Random}}$
- Imaging: 2 fMRI scans (pre-training & post training)
- Scan Parameters: (6 runs/session, TR:2000ms, MB= 3, 66 slices, 2mm$^{3,}$)
- RSA whole brain searchlight to identify regions that disciminated between finger represenations (Walther et. al. 2015)
- Beta coefficients estimated using a GLM: $\hat{\beta} = (X^T X)^{-1} X^T Y$ , and prewhitened: $b_k^* = b_k \Sigma^{-\frac{1}{2}}$




Schematic of task design

## Representational similarity analysis based plasticity




**Distance**

$$\hat{d}^2_{i,j} = \sum_{l,m;l\neq m}^{M} \frac{(\hat{u}_i^m - \hat{u}_j^m)^T (\hat{u}_i^l - \hat{u}_j^l)}{M(M-1)}$$

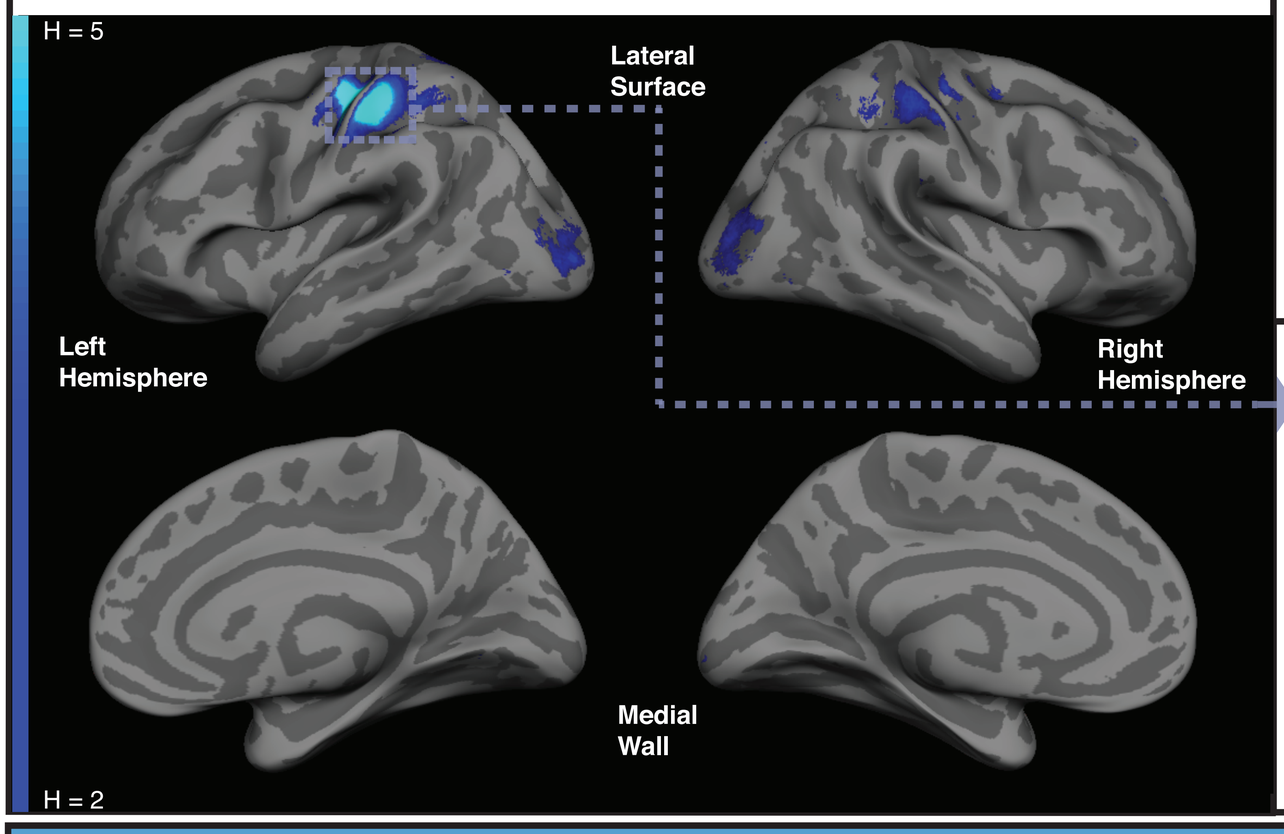
**Average distance**

$$H = \sum_{i\neq j}^{K} \frac{\hat{d}^2_{ij}}{K(K-1)}$$

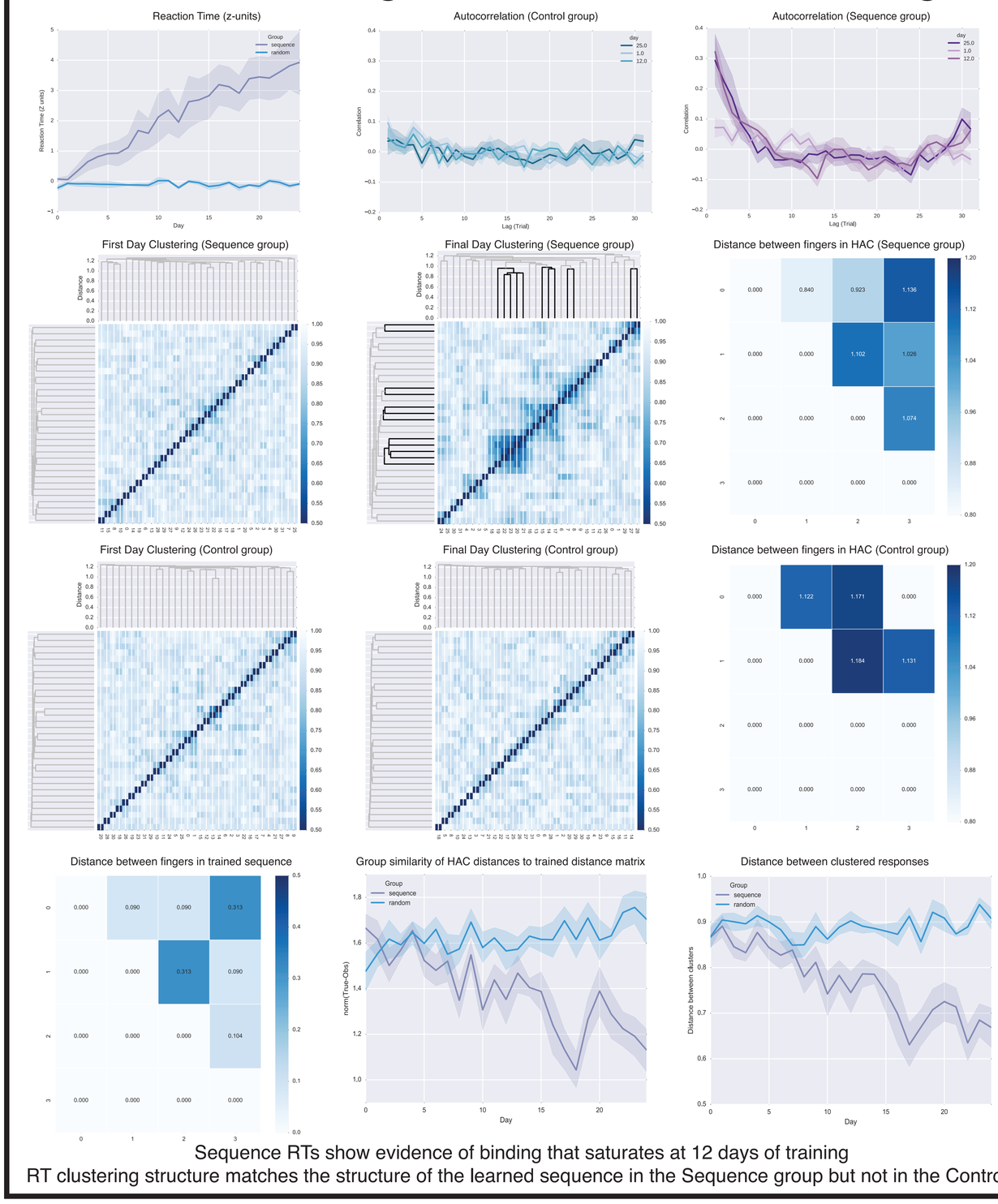
**Distance change**

$$H_{post} - H_{pre}$$

## Regions representing distinct response cues (Pre-training)



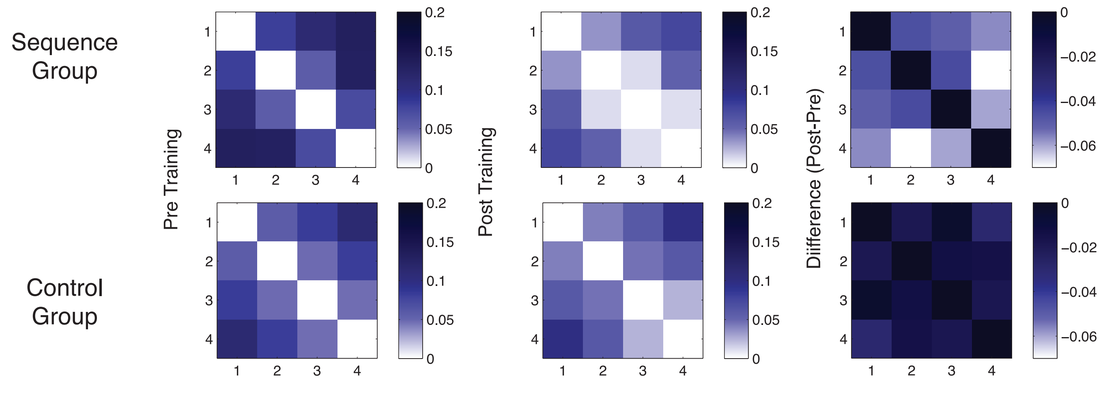

## Behavioral learning indices and hierarchical clustering




Sequence RTs show evidence of binding that saturates at 12 days of training

RT clustering structure matches the structure of the learned sequence in the Sequence group but not in the Controls

## Plasticity of movement representations in sensorimotor cortex




Sequence group exhibits decreased distances in sensorimotor cortex after training

## Summary

Distances between movement reaction times decreases with learning, as measured by both an increase in the auto-correlation and the distances between clustered movements in a hierarchical dendrogram.

Distances between the patterns of activation for individual movements also decreases in subjects that practiced the sequence but not in control subjects

## References

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