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.

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) $r = \frac{\mu - \mu_0}{\sigma}$
• Imaging: 2 MRI scans (pre-training & post-training)
• Scan Parameters: (8 runs/session, TR:2000ms, MB=3, 66 slices, 2mm)
• RSA whole brain searchlight to identify regions that distinguished between finger representations (Walther et. al. 2015)
• Beta coefficients estimated using a GLM: $\beta = (X'X)^{-1}X'Y$, and prewhitened: $\tilde{b_j} = b_j \cdot \tilde{\Sigma}_{ij}$

Representational similarity analysis based plasticity

$$\text{Data} = \text{Design} \times \text{Pattern} + \text{Noise}$$

$$H = \sum_{t=1}^{N} \frac{1}{M(M-1)} \sum_{i,j=1}^{M} (\tilde{u}_{ij} - \tilde{\mu}_j)(\tilde{u}_{ij} - \tilde{\mu}_j)$$

Behavioral learning indices and hierarchical clustering

Regions representing distinct response cues (Pre-training)

Plasticity of movement representations in sensorimotor cortex

Summary

Distances between movement reaction times decreases with learning, as measured by both an increase in the autocorrelation 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