Skill-specific changes in cortical preparatory activity during motor learning

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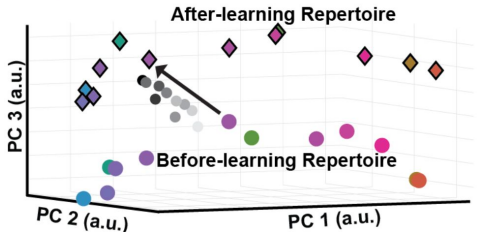
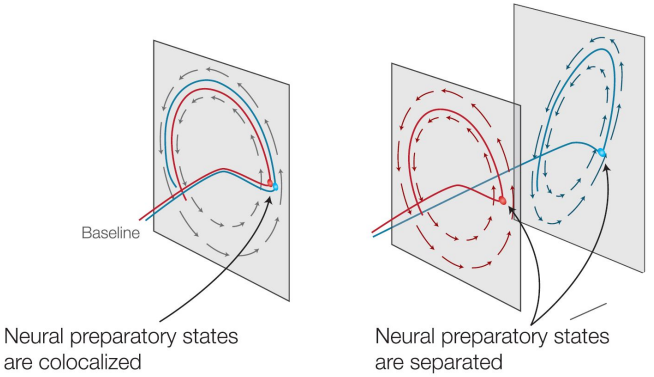
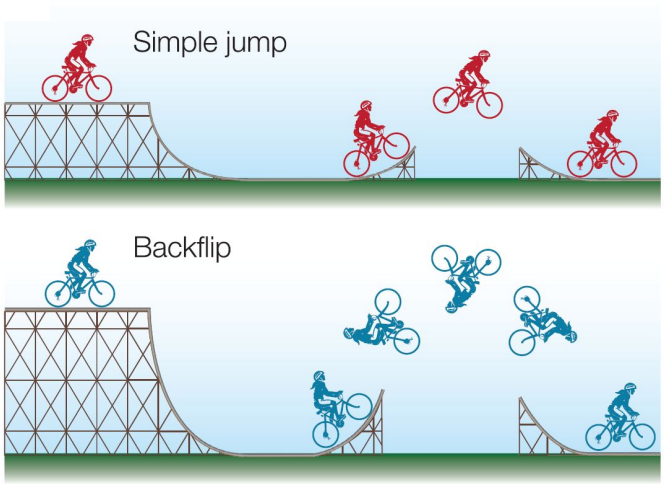
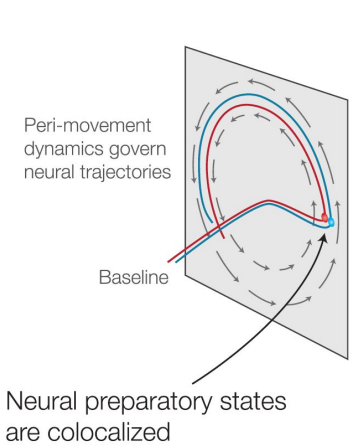
Flexible Learning reading group
11.3.2020

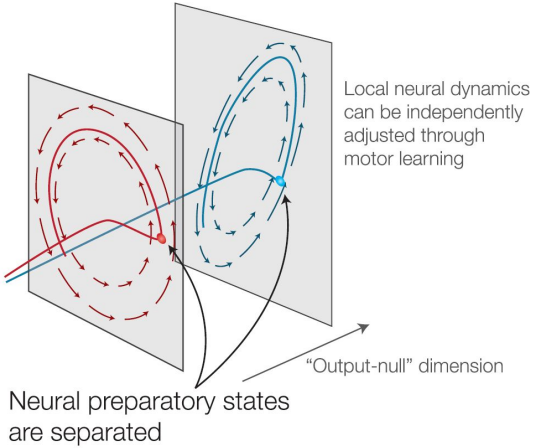




How does the brain learn multiple skills without interference?

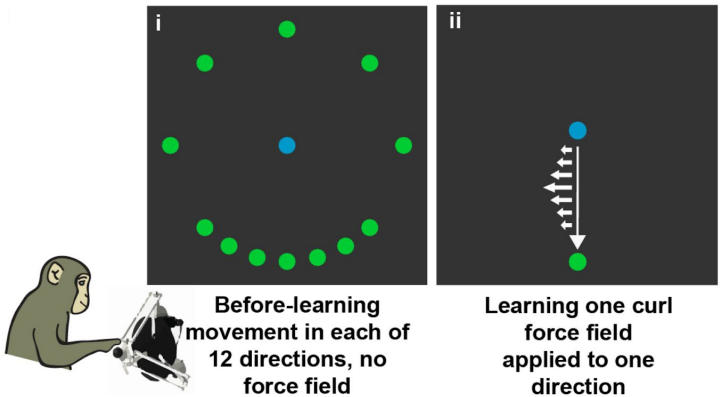


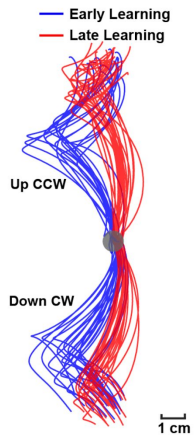


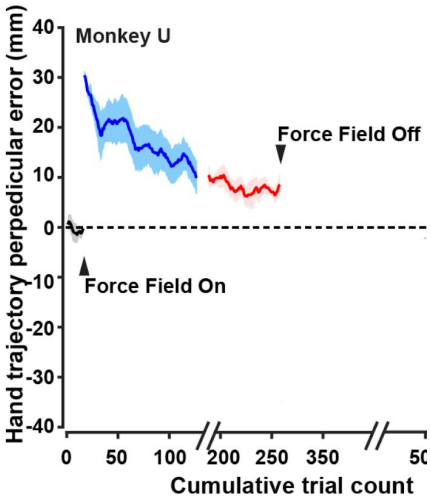


O'Shea & Shenoy; Sheahan et al. Neuron 2016

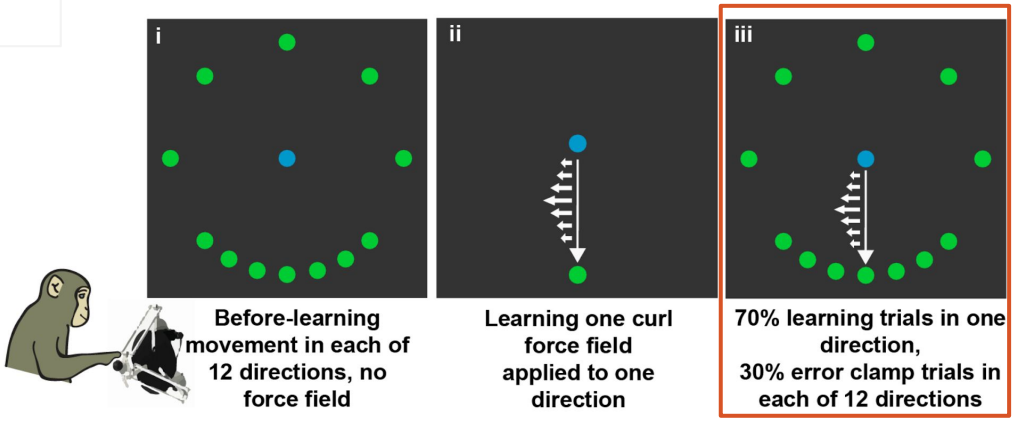
Curl force field requires learning of new movements

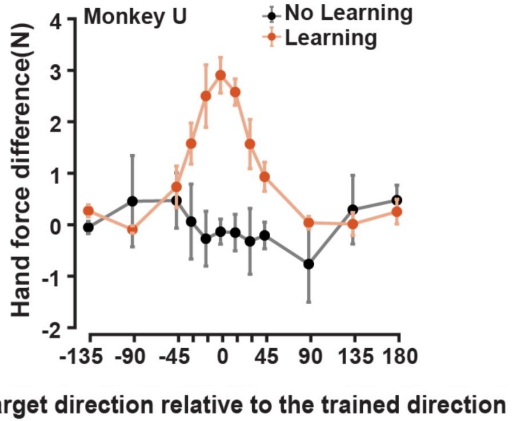




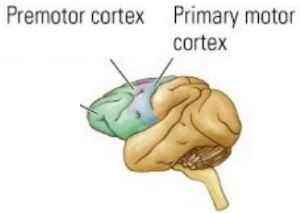


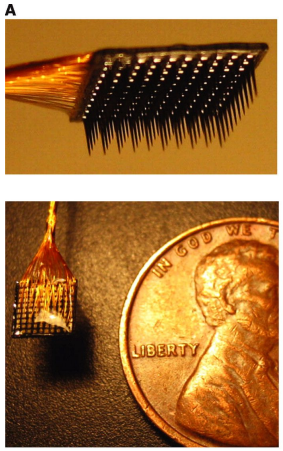
Behavioral generalization is movement-specific



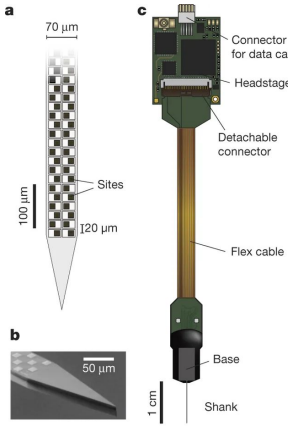


Record hundreds of neurons in motor cortex



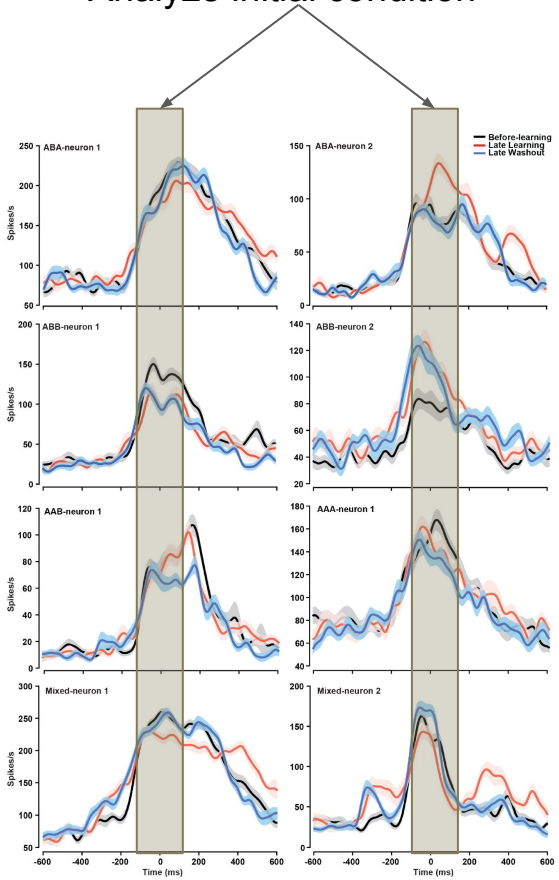


Kelly et al., J. Neurosci 2013



Jun et al., Nature 2017

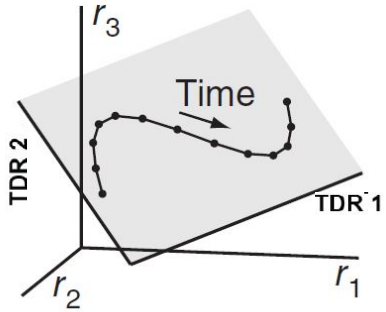
Analyze initial condition



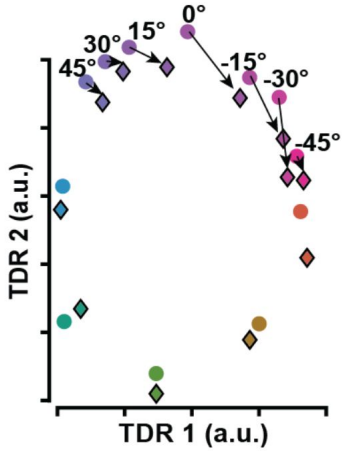
https://www.studocu.com/en-gb/document/university-of-strathclyde/psychobiology/lecture-notes/psychobiology-lecture-16/1473738/view

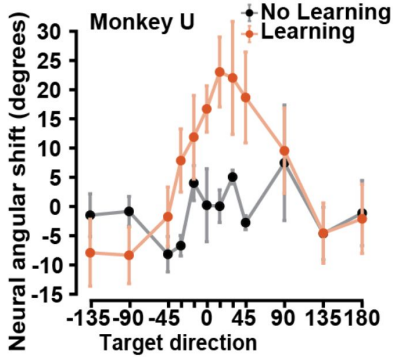
Movement-specific shift in neural activity

Movement-related subspace



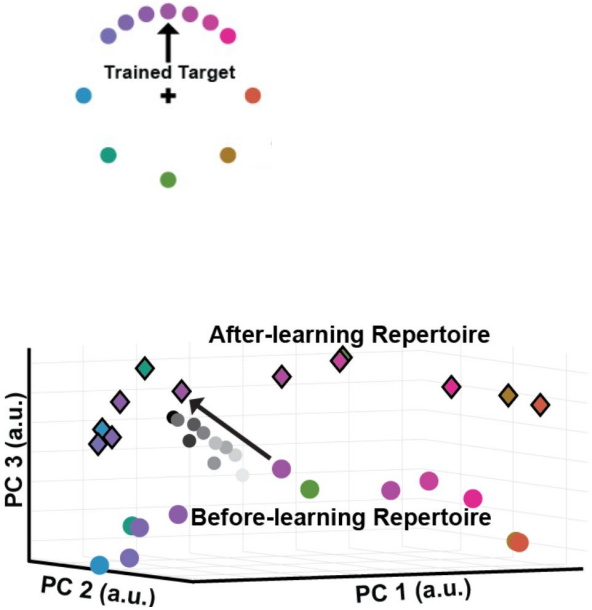
Modified from Cunningham & Yu, Nat Neuro 2014

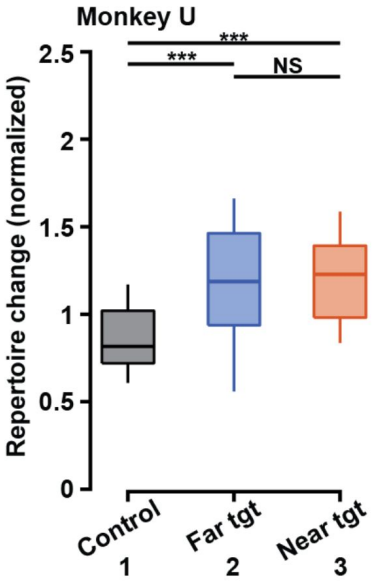


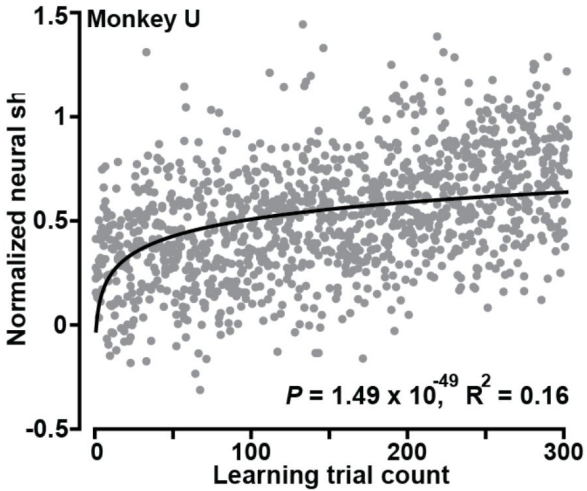


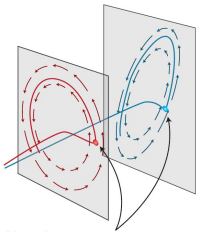
Learning by neural reassociation (Golub et al. Nat Neuro ‘18)

Uniform shift in neural activity separates movements after learning



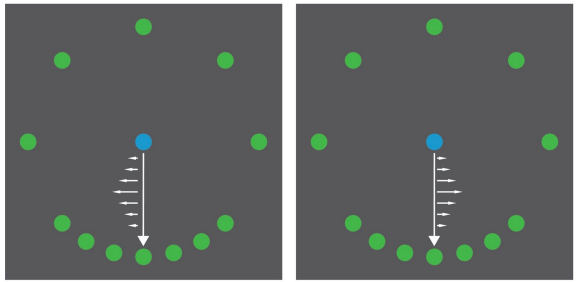




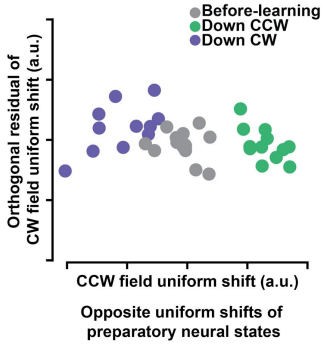


Is the uniform shift a neural mechanism for learning multiple tasks?

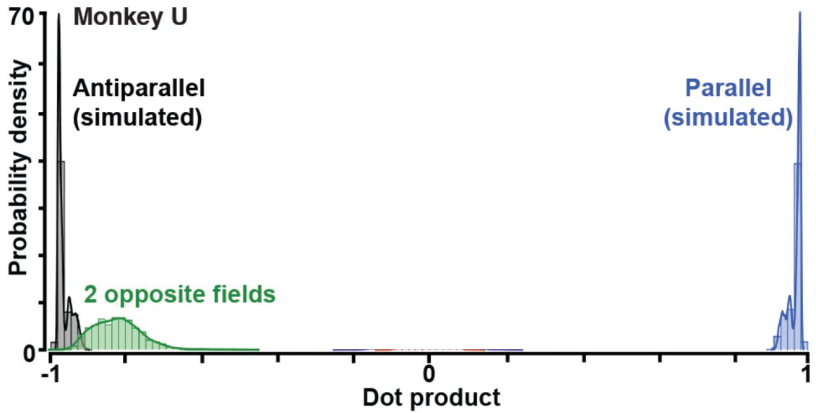
Opposite shifts when learning opposite curl fields



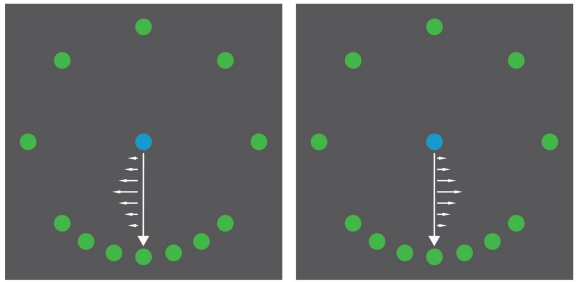
Learning two opposite curl fields sequentially applied to down reaches



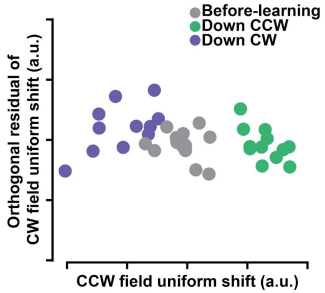
Opposite uniform shifts of preparatory neural states



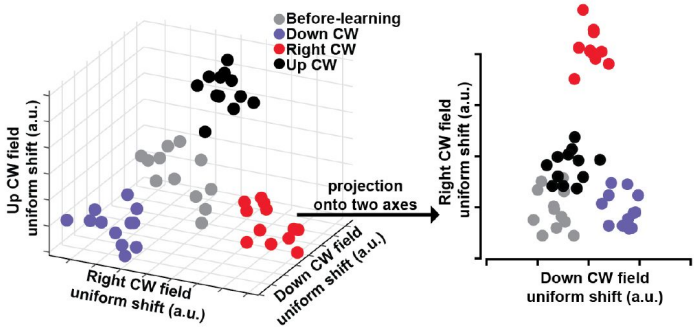
Distinct shifts when learning same force field in **different directions**

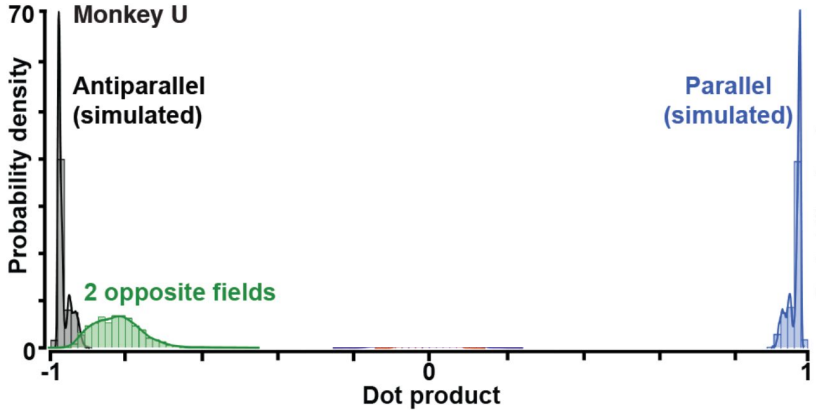


Learning two opposite curl fields sequentially applied to down reaches

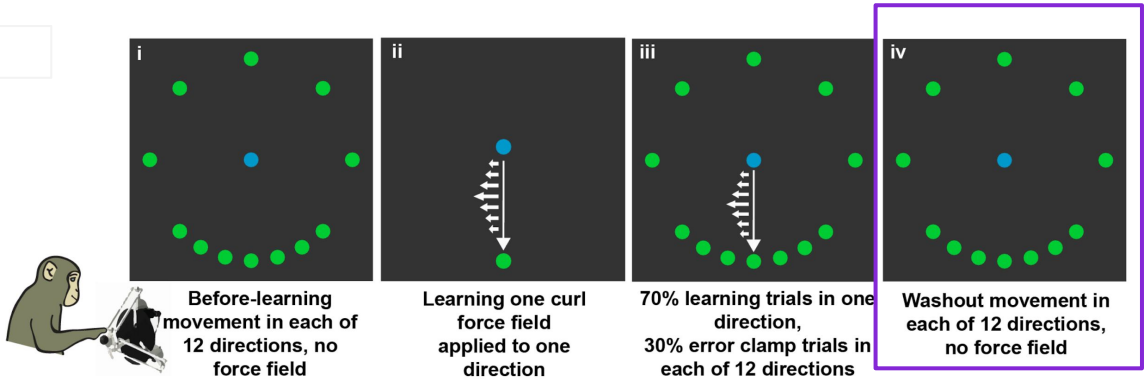


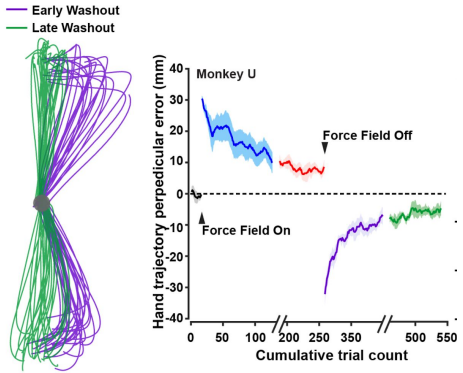
Opposite uniform shifts of preparatory neural states

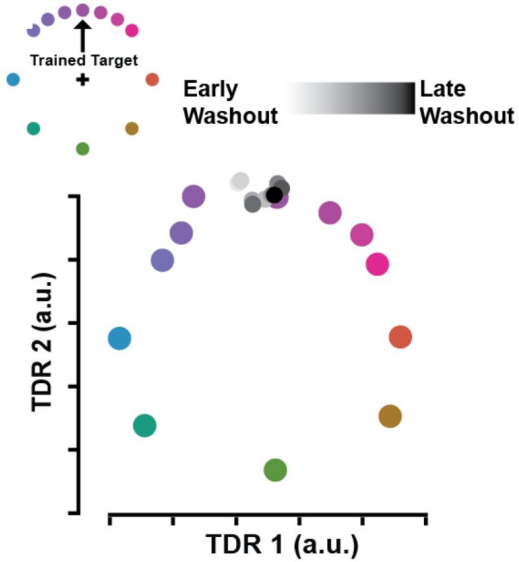




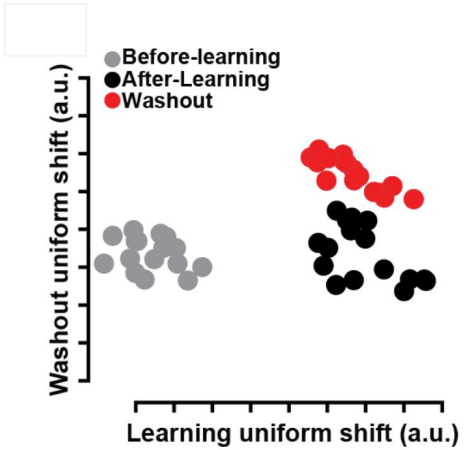
Behavior reverts back during washout

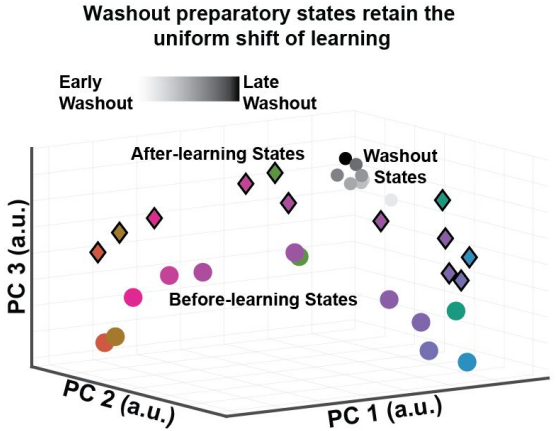


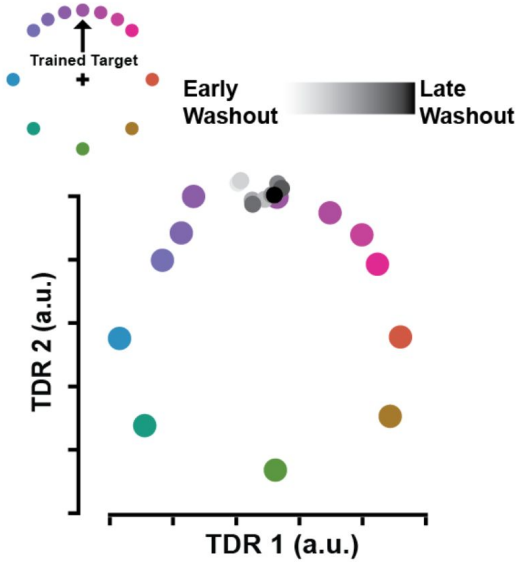




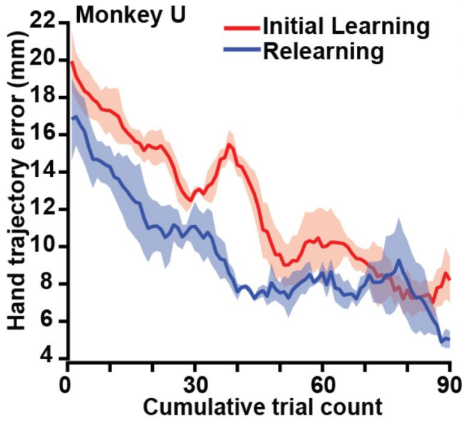
Neural **activity** does **not** revert back during washout

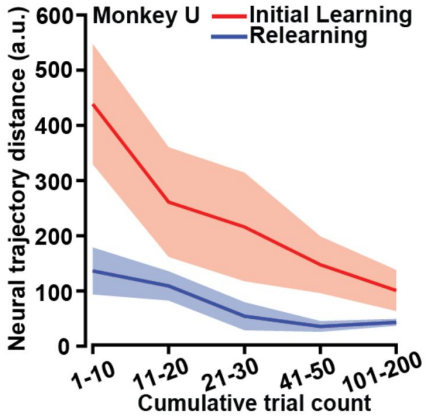


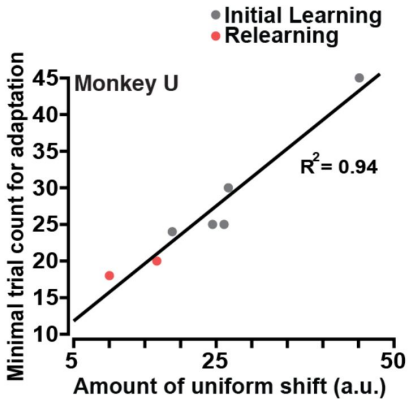




Re-learning is faster than learning

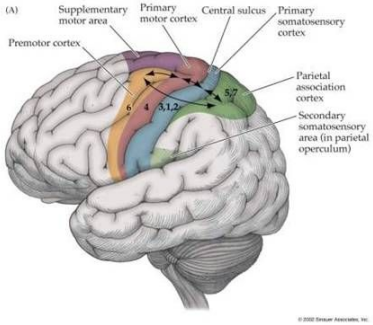




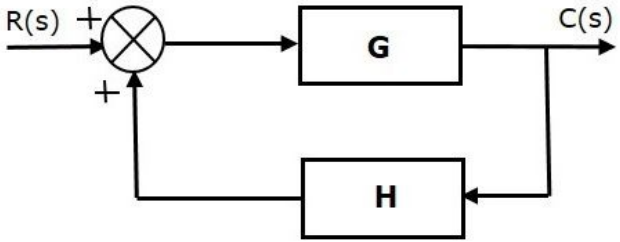


Discussion

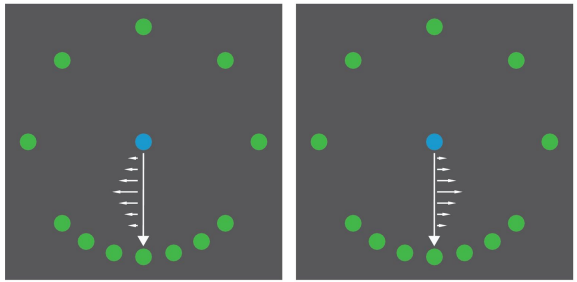
Causality



Feedback control



Meta-learning



Artificial Networks