

mediate them, demonstrate the hallmarks of efficient coding. Barlow proposed that neurons should adapt their sensitivity as stimulus conditions change in order to maintain efficient representation of sensory inputs. Evidence for efficient coding of temporal fluctuations in visual contrast has been observed in the retina. We asked whether adaptation to stimulus variance generalizes to higher cortical areas whose neurons respond to features of visual signals that do not drive adaptation in the periphery and whether such adaptation impacts performance of visually-driven behavior. Specifically, we studied the impact of cortical adaptation to fluctuations in motion direction on pursuit. We recorded eye movements of monkeys pursuing moving targets with an added stochastic perturbation. We found that the amplitude of the linear filter relating eye to target movement rescaled in proportion to target motion variance, consistent with the efficient coding hypothesis. Steps in target motion variance created a transient decrease in the information capacity of pursuit. To test whether this behavioral adaptation arises in the visual system, we recorded unit responses in middle temporal cortical area (MT). We found that MT responses echo those of pursuit: neural filters – between firing rate and target motion scale with variance, the stimulus-response distribution rescales rapidly – within 30ms of a variance change – and some units display a rapid recovery of motion information after a step.

III-87. Corresponding neural signatures of movement and imagined movement in human motor cortex

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Clinical studies have demonstrated that human primary motor cortex (M1) exhibits modulation during movement, as well as during imagined movement. In non-human primates (NHPs), population activity in M1 follows a well-described progression from movement planning to execution. Here we seek to understand whether population activity in human M1 follows this same progression. Further, we asked questions that are difficult to probe through NHP experiments: does the process of imagining movements follow a similar structure? How does population activity during imagined movements relate to real movements? We investigated these questions with a participant with ALS under the BrainGate2 clinical trial. The participant retains the ability to make several dexterous movements. We analyzed single channel and population spiking activity recorded from M1 as the participant performed finger flexion movements in an instructed-delay task. Single channels reliably modulated during the delay period (before the "go" cue), and then exhibited further modulation as the participant executed the movement. Using dimensionality reduction techniques, we analyzed trajectories in neural state space over the course of the task. Trajectories during planning moved from baseline to a preparatory state, and then progressed along a stereotyped trajectory during movement execution. During imagery blocks, the task followed the same structure, but the participant was asked to imagine the movements. Single channels exhibited modulation during planning, and further modulated after the "go" cue. We applied the previously learned dimensionality reduction transformation and found that neural activity during the delay period progressed to the same planning states as the movement paradigm. Trajectories following the "go" cue were qualitatively similar to the movement paradigm, but still distinguishable. These results demonstrate that the process of imagining movements follows the same structure as movement execution, and may lead to a better understanding of what aspects of M1 population activity drive motor output.