Parietal Reach Region Cell Classes Have Complementary Planning Responses

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Traditionally neural recordings to study arm reaches are performed during automatic behavior from over-trained subjects. These over learned reaches are already very precisely timed, with a symmetric smooth bell-shaped speed profile. It is unknown how the brain learns to compute these temporal dynamics and builds a new motor memory from naïve to automatic. It is also unknown where in the cortex these computations take place although motor learning and adaptation have been primarily studied in motor regions. This study targeted instead the reach region (PRR) of the posterior parietal cortex (PPC) and asked how the computation of new temporal dynamics manifested in the pre-movement activity of these cells. We tracked 111 PRR cells from 2 monkeys in a delayed-reach paradigm that interleaved an old automatic straight reaching task with a new obstacle (OB)-avoidance task for which the animals had not been trained. We found two complementary populations of cells that before, during and after target presentation segregated according to the mean response differences (across all spatial locations) between the automatic and the novel task. Type I cells decreased their firing rates whereas Type II cells increased. Systematic anticipatory voluntary changes in arm posture gated their responses to the same retinal input in the dark during the fixation epoch and continued in the memory period after the cue-presentation. An analyses of their amplitude-normalized waveforms according to their peak-to-valley durations as in [1] yielded a significant bimodal distribution whereby the Type I cells were broad-spiking (> 250 μs) and the Type II cells were narrow-spiking (≤ 250 μs). As the temporal profiles of the conserved postural and hand paths was being learned these cells continued to dramatically change their responses and eventually converged to their original response patterns in the automatic straight reaches, once the OB-avoidance task had also become automatic. In a control experiment where the initial posture was passively repositioned at the beginning of the session to match the voluntary adjustment, and where the same automatic straight-reaches were performed, the same cells that so dramatically changed during the learning of new temporal dynamics did not show the same learning effects. Their response differences to the passive change in initial posture were comparable to the voluntary postural change but the memory planning pattern did not change across the block trials. These data suggest a very different role of PRR neurons in automatic vs. novel tasks and posses the question of what other area(s) are driving the learning of automatic dynamics for goal-oriented reaches.

Acknowledgments

We thank Chris Buneo for assistance with training and surgical procedures in the early stages of this project. This work was supported by Sloan-Swartz Foundation, Della Martin Fellowship, James G. Boswell Foundation, National Eye Institute (NEI).

References

[1] Differential attention-dependent response modulation across cell classes in macaque visual area V4. J.F. Mitchell, K.A. Sundberg, J.H. Reynolds, *Neuron* 55:131-141, July 2007.