Self-tuning neurons and firing rate homeostasis in neocortical circuits

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Neocortical networks must generate and maintain stable activity patterns despite perturbations induced by learning and experience-dependent plasticity. There is abundant theoretical and experimental evidence that network stability is achieved through homeostatic plasticity mechanisms that adjust synaptic and neuronal properties to stabilize some measure of average activity, and this process has been extensively studied in primary visual cortex (V1), where chronic visual deprivation induces an initial drop in activity and ensemble average firing rates (FRs), but over time activity is restored to baseline despite continued deprivation. Here I discuss recent work from the lab in which we followed this FR homeostasis in individual V1 neurons in freely behaving animals during a prolonged visual deprivation/eye-reopening paradigm. We find that — when FRs are perturbed by manipulating sensory experience — over time they return precisely to a cell-autonomous set-point. Finally, we find that homeostatic plasticity is perturbed in a mouse model of Autism spectrum disorder, and this results in a breakdown of FRH within V1. These data suggest that loss of homeostatic plasticity is one primary cause of excitation/inhibition imbalances in ASD models. Together these studies illuminate the role of stabilizing plasticity mechanisms in the ability of neocortical circuits to recover robust function following challenges to their excitability.

Gina Turrigiano received her B.A. from Reed College in 1984 and her Ph.D. from UC San Diego in 1990. She trained as a post-doc with Eve Marder at Brandeis University before joining the faculty in 1994, where she is now the Levitan Professor of Vision Science in the Department of Biology. Her work has focused on identifying the cellular and circuit mechanisms that stabilize neural circuit function, especially the discovery and characterization of homeostatic forms of synaptic and intrinsic plasticity. She has received numerous awards for this research, including a MacArthur fellowship, an NIH director's pioneer award, and the HFSP Nakasone Award. She is a fellow of AAAS and an elected member of the American Academy of Arts and Sciences and the National Academy of Sciences.