Neural Signal Propagation by the External Pallidal Segment

Charles J. Wilson and James A. Jones
(see pages 6112–6125)

The indirect pathway of the basal ganglia is canonically associated with movement inhibition. It is composed of several nuclei, but its output can be measured by observing activity from external pallidal segment (GPe) neurons, which dually inhibit the substantia nigra pars reticulata and pallidal inner segment. A notable GPe neuron characteristic is that they are “intrinsic oscillators,” firing spontaneously in the absence of excitation. Their oscillations, or firing patterns, can undergo changes in frequency that differentially alter the behavioral experience and contribute to movement-related disease states. In this issue, Wilson and Jones explored the role of GPe neurons in propagating oscillations of the indirect pathway. They used whole-cell patch-clamp electrophysiology to deliver weak oscillations electrically onto GPe neurons at different frequencies. They then calculated the effectiveness of GPe neurons in passing these signals onto their postsynaptic nuclei in the indirect pathway. The investigators found that the GPe effectively propagated oscillation frequencies up to as high as 100 Hz. More specifically, they discovered that firing rates of presynaptic and postsynaptic neurons differentially impacted presynaptic and postsynaptic frequency sensitivities. Thus, firing rate changes determine which signals will be propagated or suppressed. These findings advance our understanding of disease pathology that is mediated by basal ganglia oscillation frequency and its propagation by the GPe.

Inhibition onto Hippocampal Neurons Enables Their Coordinated Firing for Memory Consolidation

Asako Noguchi, Nobuyoshi Matsumoto, and Yuji Ikegaya
(see pages 6126–6140)

Internalizing information about our surroundings and consolidating it into memories is undoubtedly critical for us to effectively function in our daily lives. Memory consolidation depends on sharp-wave ripples (SWRs) in the hippocampus. SWRs reflect rapidly oscillating summations of excitatory and inhibitory inputs and are associated with hippocampal pyramidal cell spike sequences, which synchronously replay the precise pattern of activity that occurred during an initial life experience later on for remembrance of that experience. Herein, researchers sought to elucidate how these temporally organized spike patterns mature in cells on a physiological level; they wanted to determine how intracellular membrane potentials can organize the firing patterns of each neuron during SWRs and how these subcellular traits develop. Noguchi et al. recorded membrane potentials from hippocampal pyramidal neurons individually at different developmental timepoints throughout the maturation of SWRs. They found that coordinated temporal spike patterns during SWRs were accompanied by the maturation of inhibition onto pyramidal neurons, which was strengthened as SWRs matured. Inhibitory inputs essentially restrict the time windows for neuronal spikes so that temporally precise spike sequences are generated. This work expands on our current understanding of memory consolidation and points toward novel mechanisms underlying disorganized spike sequences in immature mice.

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