Feed-forward Inhibition is Dynamically Regulated in the Dentate Gyrus

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The dentate gyrus (DG) serves as a gateway to the hippocampus and controls information transfer from the cortex to the hippocampus proper. Cortical afferent inputs provide fast and rapid excitation with subsequent feed-forward inhibition in the DG granule cells (GCs). Feed-forward inhibition in the DG is mediated by two distinct classes of inhibitory interneurons: fast-spiking (FS) vs. non-fast spiking (non-FS) cells. Detailed morphological analysis revealed that FS cells are soma-targeting interneurons, whereas non-FS cells are dendrite-targeting interneurons. Temporal information of a series of spike train is selectively captured by FS and non-FS interneurons and then is transformed into spatial of inhibition onto GCs. However, it is unclear whether these two distinct types of interneurons can reliably transform their activities into inhibitory output. Here, we show that feed-forward inhibition is dominated by reliable somatic inhibition during sparse cortical input, whereas feed-forward dendritic inhibition is rapidly switched on during high-level cortical inputs. This rapid dynamic switch of GABA release is sensitive to presynaptic activity and is mediated by 4-AP sensitive K^+ channels. The fast dynamic switch of dendritic inhibition may act as an activity-dependent filter to prevent overt excitation to the DG and set the balance of excitation and inhibition in the GCs.