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Session PSTR318 - Intrinsic Properties and Modulation of Neuronal Firing II

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PSTR318.06 / B44 - Dorsoventral gradients in intrinsic neuronal excitability of rat hippocampal granule cells and mossy cells

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Dorsoventral gradients in intrinsic neuronal excitability of rat hippocampal granule cells and mossy cells.
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S. Kumari: None. **R. Narayanan:** None.

Abstract
The dorsal, intermediate, and ventral regions of the hippocampus are well characterized in terms of their behavioural roles, anatomical features, circuit connectivity, and gene expression profiles. However, there is notable paucity of studies investigating neuronal physiological properties along the dorsoventral axis of the dentate gyrus (DG), which serves as the primary gateway to the hippocampus proper. In this study, we systematically examined the electrophysiological properties of the two excitatory neuron types in the DG—granule cells (GCs) and mossy cells (MCs)—across the dorsal, intermediate, and ventral hippocampus of Sprague Dawley rats (4-8 weeks). Behaviorally, GCs have been implicated in spatial navigation, pattern separation, and engram formation, while MCs manifest multiple place fields and play key roles in novelty detection. We observed significant dorsoventral gradients in intrinsic excitability for both GCs and MCs, with dorsal neurons (GC: ***n*** = 49; MC: ***n*** = 10) exhibiting reduced excitability—inferred from significantly lower input resistance, impedance amplitude, and firing rates—compared to their intermediate (GC: ***n*** = 43; MC: ***n*** = 14) and ventral (GC: ***n*** = 42; MC: ***n*** = 16) counterparts. Strikingly, ventral GCs in the infrapyramidal blade manifested higher firing rates compared to their counterparts in the suprapyramidal blade. These blade-specific differences were limited to the ventral GCs, with negligible distinctions between GCs in the two blades of either dorsal or intermediate hippocampus. GCs functioned as integrators, exhibiting no sag and low-pass impedance profiles. MCs, on the other hand, manifested sag and exhibited robust delta-frequency (0.5-4 Hz) resonance. MCs also showed late firing of action potentials following suprathreshold current injections, with latencies ranging from 100-300 ms for a 250-pA current. Based on these observations, we hypothesized strong expression of HCN and ***D***-type potassium channels in MCs. To test this, we applied ZD7288, a selective HCN channel blocker, which effectively abolished sag and delta-frequency resonance (***n*** = 10). Furthermore, application of α-dendrotoxin, a peptide blocker of ***D***-type potassium channels, significantly reduced firing latency to tens of milliseconds (***n*** = 7) and increased firing rates by >5 fold. Importantly, both sub- and supra-threshold excitability were higher in ventral MCs compared to their dorsal counterparts. Collectively, our findings unveil marked inter-regional heterogeneity in the intrinsic electrophysiological properties of DG excitatory neurons and underscore the functional complexity of the hippocampus along its dorsoventral axis.