GABAergic neurones control the activity of spatial coding and synchronous network activity in the hippocampal-entorhinal formation thereby affecting spatial learning

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Abstract
GABAergic interneurons are crucially involved in the generation and maintenance of rhythmic synchronous activity in many forebrain regions, including the hippocampal-entorhinal formation. Genetic manipulations affecting the recruitment of GABAergic interneurons or abolishing the electrical coupling between GABAergic interneurons highlighted the functional role of GABAergic interneurons for spatial and/or temporal coding in the hippocampus. The genetic manipulations were always associated with distinct spatial memory deficits. To manipulate activity of selective neurons “online”, we use optogenetics combined with in vivo recordings in freely moving mice. This allows the study of distinct interneurons, their connectivity with neighboring excitatory cells, as well as whether and how interneuron recruitment accounts for distinctive firing properties of spatially tuned cells. I will also present data demonstrating the presence of long-range GABAergic cells that connect the hippocampus and entorhinal cortex bi-directionally. By virtue of their connectivity – the target cells are most often local interneurons - this class of cells is ideally suited to synchronize brain regions over long distance. I will show that long-range GABAergic cells connect many more brain regions, and will discuss in more detail the motor cortex-striatum and septum entorhinal cortex connectivity. Finally I will present data pertaining to a new research direction in our lab demonstrating how neurogenesis of postnatally generated GABAergic interneurons is modulated.

Reference papers
1) Impaired Path Integration and Grid Cell Spatial Periodicity in Mice Lacking GluA1-Containing AMPA Receptors
Kevin Allen, Mariana Gil, Evgeny Resnik, Oana Toader, Peter Seeburg, and Hannah Monyer
The Journal of Neuroscience, April 30, 2014 • 34(18):6245– 6259 • 6245
2) Parvalbumin interneurons provide grid cell–driven recurrent inhibition in the medial entorhinal cortex
Christina Buetfering, Kevin Allen & Hannah Monyer
VOLUME 17 NUMBER 5 MAY 2014 nature NEUROSCIENCE
3) NMDA Receptor Ablation on Parvalbumin-Positive Interneurons Impairs Hippocampal Synchrony, Spatial Representations, and Working Memory
Tatiana Korotkova, Elke C. Fuchs, Alexey Ponomarenko, Jakob von Engelhardt, and Hannah Monyer
Neuron 68, 557–569, November 4, 2010