Joint Meeting of the Austrian Neuroscience Association (16th ANA Meeting) and the Austrian Pharmacological Society (25th Scientific Symposium of APHAR)
Innsbruck, 25–27 September 2019

MEETING ABSTRACT

A3.54

Sparse coding in identified dentate gyrus granule cells in head-fixed running mice

Xiaomin ZHANG, Alois SCHLÖGL and Peter JONAS*

Institute of Science and Technology Austria (IST Austria), Klosterneuburg, Austria

Background: Sparse activity is a hallmark feature of the dentate gyrus granule cells (GCs) and is thought to play an important role in network computations, such as pattern separation. Data acquired by tetrode recording and calcium imaging showed that only a minority of GCs was active at a very low frequency when animals explored an open field environment [1, 2, 3]. However, the mechanisms underlying the sparse activity of the GCs and the subthreshold membrane potential dynamics during spatial navigation remain unknown due to limitations of previously used recording techniques.

Methods: To address these questions, we performed whole-cell patch-clamp recordings from morphologically identified GCs, together with local field potential (LFP) recordings in head-fixed mice running on a linear belt.

Results: We found that firing properties of morphologically identified GCs were highly sparse and heterogeneous. Whereas 43% of cells were silent, 57% of cells were active to a variable degree, generating single spikes and bursts of action potentials (APs). Interestingly, active GCs had more complex dendritic trees than silent GCs, with a larger number of higher-order branches ($n = 22 / 27$, $p = 0.001$). Active GCs showed larger AP amplitude, faster AP rise and shorter AP duration ($n = 26 / 24$, $p = 0.015$, 0.0001 and 0.003). Analysis of membrane potential (V_m) dynamics during spatial navigation revealed that GCs with spatially tuned spiking also received spatially tuned inputs, indicated by more depolarized V_m, higher variance of V_m in-field than out-field, and spatial tuning vector length significantly different from that of shuffled data. Unexpectedly, we found that 25% non-place active GCs and 22% silent GCs also received spatially tuned inputs. Finally, a machine learning algorithm using the morphological, intrinsic and extrinsic properties of the current data set was able to predict the GC firing patterns.

Discussion: Our data suggests that a combination of morphological, intrinsic and extrinsic properties may synergistically contribute to the sparse and heterogeneous firing pattern of GCs *in vivo*. Spatially tuned inputs may prime GCs to encode spatial information.

Acknowledgements: This project received funding from the European Research Council (ERC) under the European Union's Horizon 2020 research and innovation programme (grant agreement no. 692692) and the Austrian Science Fund FWF (Z 312-B27, Wittgenstein award), both to P. J.

Keywords: dentate gyrus granule cells – sparse coding – place cells – *in vivo*

References

1. Senzai Y, Buzsáki G: **Physiological Properties and Behavioral Correlates of Hippocampal Granule Cells and Mossy Cells.** *Neuron,* 2017; 93(3):691–704.e5. doi:10.1016/j.neuron.2016.12.011
2. Danielson NB, Turi GF, Ladow M, Chavlis S, Petrantonakis PC, Poirazi P, Losonczy A: **In Vivo Imaging of Dentate Gyrus Mossy Cells in Behaving Mice.** *Neuron,* 2017; 93(3):552–559.e4. doi:10.1016/j.neuron.2016.12.019
3. GoodSmith D, Chen X, Wang C, Kim SH, Song H, Burgalossi A, Christian KM, Knierim JJ: **Spatial Representations of Granule Cells and Mossy Cells of the Dentate Gyrus.** *Neuron,* 2017; 93(3): 677–690.e5. doi:10.1016/j.neuron.2016.12.026

*Corresponding author e-mail: *peter.jonas@ist.ac.at*

