IN BRIEF

ASTROCYTES

Getting in on the action (potential)

Whether astrocytes are able to regulate neurotransmission and local blood flow over short (millisecond) timescales is unclear. Here, genetically encoded calcium indicators and simultaneous two-photon imaging were used to monitor spatiotemporal calcium dynamics within fine astrocyte processes and endfeet in layer II/III whisker barrel cortex of awake mice. During spontaneous activity and neuronal activity evoked by whisker stimulation, astrocytes showed fast calcium signals that rapidly followed nearby neuronal activity, suggesting that astrocyte signals are fast enough to contribute to synaptic modulation and neurovascular coupling.

ORIGINAL ARTICLE Stobart, J. L. et al. Cortical circuit activity evokes rapid astrocyte calcium signals on a similar timescale to neurons. *Neuron* https://doi.org/10.1016/j.neuron.2018.03.050 (2018)

PSYCHIATRIC DISORDERS

Lifting spirits

Dysfunction of the hippocampal formation is thought to contribute to major depressive disorder, but the role of the entorhinal cortex (Ent) is unknown. Here, molecular and chemogenetic approaches were used to selectively excite Ent→dentate gyrus (DG) projections. Compared with controls, these mice showed increased hippocampal neurogenesis and antidepressive-like behaviour in models of depression and chronic stress, effects that were lost when neurogenesis was ablated by X-ray irradiation, suggesting that they are neurogenesis-dependent.

ORIGINAL ARTICLE Yun, S. et al. Stimulation of entorhinal cortex–dentate gyrus circuitry is antidepressive. *Nat. Med.* **24**, 658–666 (2018)

NEURAL CODING

Keeping track of time

The hippocampus encodes the temporal relationship between events, but how it does this over both short (seconds to minutes) and long (hours to days) timescales is not known. Here, neuronal activity in CA1 pyramidal cells was measured while mice ran on a treadmill to receive a sucrose reward. Ensembles of CA1 pyramidal cells that exhibited sequences of spiking that differed over different timescales ('time cells') were monitored using in vivo calcium imaging. The same time cells that encode temporal information over seconds also encode information over longer timescales in which the ensemble of neurons involved gradually change over time.

ORIGINAL ARTICLE Mau, M. et al. The same hippocampal CA1 population simultaneously codes temporal information over multiple timescales. *Curr. Biol.* https://doi.org/10.1016/j.cub.2018.03.051 (2018)

NEUROGENETICS

Setting the pace

Different patterns of neuronal activity differentially induce sets of activity-regulated genes (ARGs), but the mechanisms are poorly understood. Here, RNA-sequencing approaches were used to identify ARGs and transcriptional regulators that were induced by different activity patterns in mouse cultured cortical neurons. Different durations of neuronal activation activated specific inducible signalling pathways (including MAPK/ERK) that regulated distinct waves of ARG expression that are each independently coupled to different activity patterns.

ORIGINAL ARTICLE Tyssowski, K. M. et al. Different neuronal activity patterns induce different gene expression programs. *Neuron* https://doi.org/10.1016/j.neuron.2018.04.001 (2018)

HIPPOCAMPUS

A regional divide

The hippocampus has been hypothesized to contribute to multiple cognitive functions through parallel processing pathways within its microcircuits. Cembrowski et al. now provide further support for this model, demonstrating that the mouse hippocampal subiculum contains two discrete populations of pyramidal neurons that make distinct contributions to spatial working memory.

Credit: Tamara Kulikova/Alamy Stock Photo

Previous work in rats suggested that 'subclasses' of subiculum pyramidal cells (subPCs) have different physiological properties; however, these subPC subclasses have not been characterized in detail. Here, the authors used retrograde labelling to show that, in mice, two spatially separate populations of subPCs project to distinct downstream targets: those in the proximal subiculum projected to a set of targets that included the nucleus accumbens and prefrontal cortex, whereas those in the distal subiculum projected to a different set of targets that included the retrosplenial cortex and ventral hypothalamic nuclei. Electrophysiological analyses demonstrated that the two populations also exhibit different firing properties, with proximal subPCs displaying a regular spiking phenotype and distal subPCs displaying a bursting firing pattern.

Population RNA sequencing revealed distinct gene expression patterns in the proximal and distal subPC populations and, using in situ hybridization, the authors found that a transcriptional boundary divides these two discrete populations. Single-cell RNA sequencing confirmed that subPCs cluster into transcriptionally distinct populations that correspond to either the proximal or distal population of subPCs.

To determine the relationship between the molecular phenotypes of subPCs and their connectivity, the authors injected tracers into regions that are upstream or downstream of the subiculum, including the entorhinal cortex and the amygdala. They discovered that the proximal and distal subPCs exhibit different patterns of afferent and efferent connectivity. Local circuits within these regions also differed: neuropeptide Y-expressing interneurons were specifically enriched in the proximal subPC region.

These connectivity differences imply that different subPC populations may have specific functions in cognitive processing. To examine this possibility, the authors investigated the effects of chemogenetically silencing each subPC population on the performance of mice in a spatial working memory task. Silencing the proximal subPCs had no effect on performance; however, silencing the distal PCs specifically impaired the animals' ability to encode new spatial working memories.

These findings indicate that subPCs can be divided into a least two subclasses that are molecularly, spatially and functionally distinct, providing support for the concept of separate and parallel processing pathways within the hippocampus.

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ORIGINAL ARTICLE Cembrowski, M. S. et al. Dissociable structural and functional hippocampal outputs via distinct subiculum cell classes. *Cell.* https://doi.org/10.1016/j.cell.2018.03.031 (2018)