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IN BRIEF

TECHNIQUES

The power of radio waves

Until now, the use of optogenetic techniques to depolarize neurons in awake behaving animals has required the animal to wear a head-mounted device to deliver a light source. Now, a miniaturized wireless device that is powered and controlled by radio waves has been developed and can be implanted subcutaneously. The device delivers enough light to activate channelrhodopsins in the central or peripheral nervous systems, thus enabling neuronal depolarization while observing less restricted behaviour than previously possible.

ORIGINAL RESEARCH PAPER Montgomery, K. L. *et al.* Wirelessly powered, fully internal optogenetics for brain, spinal and peripheral circuits in mice. *Nat. Methods* http://dx.doi.org/10.1038/nmeth.3536 (2015)

NEURONAL CIRCUITS

Fear and anxiety generalization

The mechanisms underlying the development of sustained anxiety are not well understood but it has been suggested that the extended amygdala, which includes the bed nucleus of the stria terminalis (BNST), is involved. Here, fear conditioning and fear generalization (a marker of sustained anxiety) are shown to involve overlapping populations of PKCδ-expressing neurons in the central nucleus of the amygdala. Moreover, increases in activity of these neurons driven by aversive stimuli is regulated by extrasynaptic inhibition of α5 subunit-containing GABA type A receptors by GABAergic projections from the BNST.

ORIGINAL RESEARCH PAPER Botta, P. *et al.* Regulating anxiety with extrasynaptic inhibition. *Nat. Neurosci.* http://dx.doi.org/10.1038/nn.4102 (2015)

LEARNING AND MEMORY

Remembering in space and time

Although events occurring over short timescales and distances are represented in the hippocampus, whether the longer times and distances are also represented is not known. Human participants who were asked to recall events from the previous month while undergoing functional MRI exhibited neural activity patterns in the left anterior hippocampus that differed according to the spatial or temporal proximity of the original experiences. Furthermore, the spatial distance and temporal distance between memories were significantly correlated with neural distance in the left anterior hippocampus, suggesting a specific spatiotemporal organization of memories that are separated in space and time.

ORIGINAL RESEARCH PAPER Nielson, D. M. *et al.* Human hippocampus represents space and time during retrieval of real-world memories. *Proc. Natl Acad. Sci. USA* **112**, 11078–11083 (2015)

NEUROBIOLOGY OF REWARD

Predicting the unexpected

The calculation of prediction error, that is, the difference between the expected reward from a task and the actual result, is important for associative learning. It is calculated by ventral tegmental area dopaminergic (VTA DA) neurons, but the mechanism is not known. In a classical conditioning paradigm, changing the temporal expectation of a reward resulted in alterations in VTA DA neuron activity — when a cue correctly predicted a reward, VTA DA neuron activity would be suppressed (and vice versa). These activity changes, achieved by a subtraction computation, were found to be mediated by local GABAergic inputs that encode reward expectation, indicating a role for this circuit in reinforcement learning.

ORIGINAL RESEARCH PAPER Eshel, N. *et al.* Arithmetic and local circuitry underlying dopamine prediction errors. *Nature* http://dx.doi.org/10.1038/nature14855 (2015)