IN BRIEF

LEARNING AND MEMORY

Each to their own

Memory processes associated with olfactory learning in *Drosophila* were investigated by training flies to associate a specific odour with a punishing or rewarding stimulus, such as an electric shock or sugar. The sparsely distributed memory trace (that is, the engram) that encodes the association between cue and stimulus is located in Kenyon cell synapses in the mushroom body of the fly brain. The activity of individual Kenyon cell synapses was monitored using a fluorescent Ca^{2+} sensor expressed throughout the axonal arbour and showed, unexpectedly, that individual boutons showed specific and individual responses to odours, suggesting that the encoding of memory occurs at the level of individual synapses.

ORIGINAL ARTICLE Bilz, F. et al. Visualization of a distributed synaptic memory code in the *Drosophila* brain. *Neuron* https://doi.org/10.1016/j.neuron.2020.03.010 (2020)

SENSORY PROCESSING

Multifunctional opsins

Chemical perception of harmful substances such as the bitter plant compound aristolochic acid (ARI) is performed in *Drosophila* by specialized peripheral gustatory receptor neurons (GRNs). Here, three opsins, Rh1, Rh4 and Rh7 are shown to be expressed on the same GRNs within the fly mouthparts. Low concentrations of ARI activate these opsins, triggering a signalling cascade involving TRPA1 that leads to GRN activation. Triple mutant flies lacking all three opsins show marked impairments in detection of low ARI concentrations. Higher ARI concentrations were found to activate TRPA1 directly and suggest that the GRN-expressed opsins function to amplify signals that would otherwise be too low to detect.

ORIGINAL ARTICLE Leung, N. Y. et al. Functions of opsins in *Drosophila* taste. *Curr. Biol.* https://doi.org/10.1016/j.cub.2020.01.068 (2020)

COGNITIVE NEUROSCIENCE

Gained in translation

Although speech can be decoded from human brain signals using brain-machine interfaces, progress is hampered by low decoding speed and poor accuracy. Here, the authors took advantage of the conceptual similarity between computerized language translation and translating speech-related neural activity detected by electrocorticogram. An encoder–decoder system was developed in which the sequences of signals obtained during spoken sentences were encoded into abstract representations and were then decoded into single words and assembled into sentences, resulting in language decoding at a speed similar to normal speech.

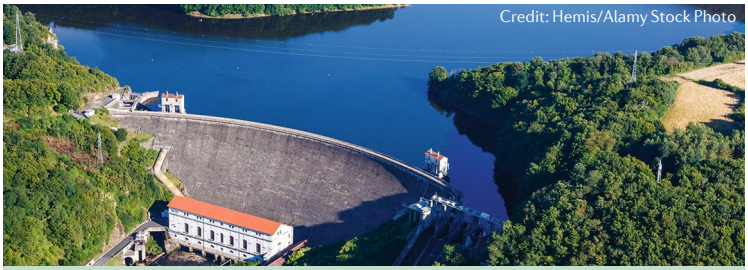
ORIGINAL ARTICLE Makin, J. G. et al. Machine translation of cortical activity to text with an encoder–decoder framework. *Nat. Neurosci.* **23**, 575–582 (2020)

GLIA

The root of the matter

There are two types of macrophage in the brain: microglia (which reside in the parenchyma) and non-parenchymal brain-associated macrophages (BAMs). Whether these two populations arise from the same embryonic precursor and/or have distinct lineages is not clear. In-depth spatiotemporal transcriptomic analysis during mouse embryogenesis revealed two distinct macrophage populations detectable at embryonic day 10.5, with one giving rise to macrophages and the other giving rise to BAMs. In addition, TGF-βR was found to control microglia accumulation and identity, whereas this was not the case for BAMs. Together these findings reveal two phenotypically distinct macrophage populations that diverge early in embryogenesis.

ORIGINAL ARTICLE Utz, S. G. et al. Early fate defines microglia and non-parenchymal brain macrophage development. *Cell* https://doi.org/10.1016/j.cell.2020.03.021 (2020)



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NEURODEVELOPMENTAL DISORDERS

Channel problems

Fetal alcohol exposure can result in life-long cognitive deficiencies. However, the molecular bases of the effects of alcohol on the developing brain have not been clear. Now, Mohammad et al. show in mice that the calcium-activated potassium channel KCNN2 (also known as SK2) is upregulated in cortical neurons following prenatal alcohol exposure and contributes to alcohol-induced deficits in motor skill learning.

The authors studied mice that received an acute prenatal alcohol exposure (PAE) on embryonic day 16 (E16) and E17, when neurons in the upper cerebral cortex are predominantly generated. At postnatal day 30, body weight, brain size and weight, locomotor activity and anxiety-like behaviour did not differ markedly between PAE mice and control mice that had been prenatally exposed to saline. However, motor skill learning was impaired in PAE mice, as reflected by their reduced learning in the accelerated rotarod test compared with controls. Similarly, in a test of fine motor skills, PAE mice were up to 3-fold less successful in reaching for and obtaining a single pellet than were the control mice. Together, these data show that fetal alcohol exposure impairs motor skill learning.

Previous studies in mice revealed that the cytoprotective heat shock signalling pathway is upregulated in neural progenitor cells (NPCs) in the alcohol-exposed fetal brain. Here, the authors used in utero electroporation to selectively express red fluorescent protein (RFP) in NPCs with activated heat shock signalling in the developing primary motor cortex (M1). Alcohol exposure had no obvious effects on NPC proliferation or differentiation, or on the migration or morphology of their excitatory neuron progeny in cortical layers II/III. However, single-cell RNA sequencing revealed altered expression of multiple genes, including some involved in synaptic plasticity and long-term potentiation, in RFP^+ neurons compared with RFP^- neurons. Notably, the transcriptional profiles of RFP^+ neurons were more heterogeneous than those of RFP^- neurons, mirroring the heterogeneity in heat shock signalling response in NPCs. Thus, NPC exposure to alcohol has lasting effects on the molecular properties of their neuronal progeny.

RFP^+ neurons showed an upregulation of *Kcnn2*, and KCNN2 expression was higher in the M1 of PAE mice than in that of control mice. Furthermore, electrophysiological abnormalities in layer III RFP^+ neurons were reversed by treatment of M1 slices with the KCNN2 blocker tamapin. Importantly, *Kcnn2* expression in RFP^+ M1 neurons correlated with the learning deficits in PAE mice, and KCNN2 inhibition (by postnatal tamapin administration or *Kcnn2* knockdown in layer II and III excitatory neurons in M1) ameliorated the learning deficits in PAE mice.

This study reveals a role for KCNN2 in motor learning deficits following fetal alcohol exposure and suggests KCNN2 inhibitors may have potential in the treatment of learning disability in individuals with fetal alcohol exposure disorders.

Grant Otto

ORIGINAL ARTICLE Mohammad, S. et al. Kcnn2 blockade reverses learning deficits in a mouse model of fetal alcohol spectrum disorders. *Nat. Neurosci.* **23**, 533–543 (2020)