This Week in The Journal

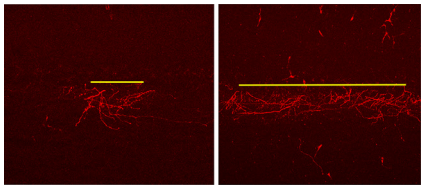
Development/Plasticity/Repair

Adult-Born Granule Cells Maintain Olfactory Bulb Organization

Diana M. Cummings, Jason S. Snyder, Michelle Brewer, Heather A. Cameron, and Leonardo Belluscio

(see pages 13801–13810)

Olfactory sensory neurons expressing the same odorant receptor converge onto two isofunctional columns in the olfactory bulb. Paired isofunctional columns are connected by tufted cell axons, which synapse on GABAergic granule neurons. After a postnatal refinement period during which intrabulbar projections narrow to the width of a single glomerulus, the projection patterns remain relatively stable throughout life, despite the continuous addition of new granule cells in mice. In fact, this stability requires the addition of adult-born granule neurons, as shown by Cummings et al. After neuronal stem cells were ablated, intrabulbar projections broadened. Similar broadening normally occurs after olfactory deprivation, but the original pattern reemerges when sensory input is restored. Re-refinement of intrabulbar projections after sensory deprivation and restoration was prevented by stem-cell ablation, however. Because olfactory deprivation alone causes granule cell loss, and newborn granule cells are added when input is restored, the authors propose that the width of intrabulbar projections is influenced by the number of target granule cells.



In normal olfactory bulb (left), tufted cell axons extend approximately the width of a single glomerulus. When adult neurogenesis is prevented (right), the arbors widen. See the article by Cummings et al. for details.

Systems/Circuits

Responses in Locus Ceruleus Reflect Actions More Than Cues

Rishi M. Kalwani, Siddhartha Joshi, and Joshua I. Gold

(see pages 13656–13669)

The locus ceruleus (LC) and the adjacent subceruleus nucleus (subC) are the brain's primary sources of norepinephrine, which has roles in arousal, attention, and learning. Neurons in LC respond phasically to reward-indicating stimuli, particularly when those stimuli elicit an abrupt behavioral response. To investigate whether this activity is more related to the salience of the stimulus or the decision to act, Kalwani et al. recorded single units in LC+subC as monkeys performed a saccadic countermanding task. Most neurons showed distinct responses when the saccade target (the "go" signal) appeared and when the instructed saccade began. In contrast, neurons did not respond when the fixation target (the "stop" signal) reappeared or when the saccade was correctly aborted, even though such stops were rewarded. Moreover, neurons showed activity at the onset of saccades made in error after a stop signal appeared, even though such saccades were not rewarded. Overall, neuronal activity appeared to reflect the decision to saccade, regardless of whether the saccade was rewarded.

Behavioral/Cognitive

Working Memory Deficits Can Impair Reinforcement Learning

Anne G.E. Collins, Jaime K. Brown, James M. Gold, James A. Waltz, and Michael J. Frank

(see pages 13747–13756)

Although delusions and hallucinations are the symptoms most commonly associated with schizophrenia, cognitive impairment typically emerges before the onset of other symptoms and persists throughout the disease. Cognitive impairment involves deficits in diverse functions, including attention, working memory, executive control, reinforcement learning, episodic memory, and sensory processing. Many of these deficits might stem from an inability to maintain representations of task-relevant information. Using a learning task that allows dissociation of working memory and reinforcement learning, along with a computational model that includes both components, Collins et al. found that deficits in working memory were sufficient to explain impairments in reinforcement learning in schizophrenics. In particular, while the number of items to learn (working memory load) affected patients' performance more than healthy subjects', the number of presentations of an item (amount of reinforcement) affected schizophrenic and healthy subjects similarly. Modeling suggested that patients had a smaller working memory capacity, were more prone to forgetting, and relied less on working memory than controls.

Neurobiology of Disease

Mutant α-Synuclein Increases Spike Rate of Nigral Neurons

Mahalakshmi Subramaniam, Daniel Althof, Suzana Gispert, Jochen Schwenk, Georg Auburger, et al.

(see pages 13586–13599)

Parkinson's disease (PD) is characterized by loss of dopaminergic neurons selectively in the substantia nigra (SN) and by intraneuronal inclusions containing α-synuclein. PD-causing mutations in α-synuclein promote its accumulation, impair intracellular degradation processes and mitochondrial functions, and disrupt redox balance. These effects occur ubiquitously, however: what makes SN neurons particularly vulnerable to degeneration remains unknown. Subramaniam et al. have found a clue to this mystery. Overexpressing human mutant α-synuclein in mice caused a progressive increase in spike rate in SN dopaminergic neurons. In contrast, firing of dopaminergic neurons in the ventral tegmental area, which are relatively unaffected in PD, was not noticeably affected by the mutation. The increased spike rate of SN neurons appeared to stem from a reduction in the maximal conductance of A-type Kv4.3 potassium channels—which regulate spike frequency in these neurons—as a result of oxidative modification of the channel. Treatment of brain slices with a reducing agent restored A-type currents and reduced spike rate.