Anatomical, physiological and behavioral dissection of an amygdala–midbrain circuit
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The central amygdala (CeA) is known to orchestrate learned fear responses via multiple subcortical projections. In addition to its well-described role in fear, the CeA influences other cognitive processes including reward learning. However, the nature of this influence, as well as the underlying circuit and synaptic mechanisms, remain largely unexplored. Midbrain dopamine neurons perform essential computations that are required for many aspects of reward learning. Accordingly, we hypothesized that the robust projection from the CeA to the substantia nigra pars lateralis (SNL)—a heterogeneous region containing dopamine, GABA and glutamate neurons—was well-positioned to link amygdala signals with downstream effectors of reward learning. Using multiple viral tracing strategies and single-cell gene expression analysis, we found that SNL-projecting CeA neurons are anatomically and genetically distinct from those that project to brain areas associated with fear and anxiety. Consistent with our hypothesis, optogenetic activation of CeA–SNL projections was sufficient to support a specific subset of reward-related behaviors, establishing a selective functional role for CeA–SNL projections in reward learning. Ongoing physiology experiments seek to identify the microcircuit architecture through which CeA activity influences synaptic transmission in the SNL and beyond. Collectively, these experiments provide valuable insight into the complex neural interactions that endogenously regulate the brain’s reward circuitry.