Meeting Abstract

Exploring the neural mechanism by which optogenetic stimulation of ventral tegmental area dopamine neurons prevents extinction of cued approach behavior
Cindy Reyes* and Saleem Nicola
Department of Neuroscience, Albert Einstein College of Medicine, Bronx, NY, United States of America

When an environmental stimulus predicts a reward at a specific location, animals learn to approach that location in response to the stimulus. When the stimulus no longer predicts reward, the approach behavior extinguishes. Recordings from dopamine (DA) neurons during conditioned approach tasks have demonstrated that DA neurons in the ventral tegmental area (VTA) burst in response to the delivery of an unexpected reward; conversely, when predicted rewards are omitted, there is a characteristic pause in firing. This suggests that DA neurons encode reward prediction errors (RPEs), which serve to update the current state and alter the strength of cue–reward associations depending on the valence of the RPE (positive or negative). While RPEs presumably lead to changes in response probability, the neural mechanisms downstream of the RPE signal that mediate this behavior remain unknown.

Many nucleus accumbens (NAc) neurons exhibit cue-evoked excitations that are required for approach behavior. We hypothesized that negative RPE signals carried by the pause in VTA DA neuronal activity may result in decreased cue-evoked firing of NAc neurons in subsequent trials, lowering the probability of cued approach. To test this hypothesis, we used a conditioned approach task with a reward omission paradigm, and recorded from neurons in the NAc in Th::Cre rats that express channelrhodopsin in VTA DA neurons. During a 30 min baseline period, auditory cues predicted the availability of a sucrose reward contingent on entry into a receptacle. Sucrose reward was then omitted for the rest of the 90 min session, leading to a decrease in responding. Using multi-electrode recording of NAc unit firing, we found a reduction in the magnitude of cue-evoked excitations of NAc neurons on trials subsequent to the reward omission. Additionally, we found that optical stimulation of VTA DA neurons at the time when reward was omitted was sufficient to prevent extinction. By recording from NAc neurons during optical stimulation trials, we will be able to determine if the reduction in cue-evoked excitations is prevented, thereby suggesting a mechanism by which phasic dopamine release modulates cue-evoked NAc neuronal excitations on subsequent trials.

*Submitting author e-mail: cindy.reyes@phd.einstein.yu.edu