Phasic firing of dopamine neurons is key to brain's prediction of rewards

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Researchers are one step closer to understanding the neurobiology that allows people to successfully learn motivated behaviors by associating environmental cues with rewarding outcomes, according to a study published yesterday in the *Proceedings of the National Academy of Sciences*' online Early Edition. Carlos Paladini, assistant professor of neuroscience at The University of Texas at San Antonio (UTSA) and UTSA graduate student Collin Lobb collaborated with researchers at The University of Washington at Seattle to study the firing patterns of midbrain dopamine neurons in mice during reward-based learning.

"Our research findings provide a direct functional link between the bursting activity of midbrain dopamine neurons and behavior. The research has significant applications for the improvement of health, because the dopamine neurons we are studying are the same neurons that become inactivated during Parkinson's Disease and with the consumption of psychostimulants such as cocaine and amphetamine," said Paladini, who is also a member of UTSA's Neurosciences Institute.

Midbrain dopamine neurons fire in two characteristic modes, tonic and phasic, which are thought to modulate distinct aspects of behavior. When an unexpected reward is presented to an individual, midbrain dopamine neurons fire high frequency bursts of electrical activity. Those bursts of activity allow us to learn to associate the reward with cues in our environment, which may predict similar rewards in the future.

The burst of electrical spikes observed in dopamine neurons is facilitated by a protein called the NMDA receptor, which is expressed on the surface of the dopamine cells. In this study, researchers removed the NMDA receptor from the dopamine cells only, leaving the dopamine neurons unable to fire bursts. The cells would otherwise fire normally.

When researchers placed the mice in reward-based situations, they found that the mice without the NMDA receptor in their dopaminergic neurons could not learn tasks that required them to associate sensory cues with reward. Those same mice, however, were able to learn tasks that did not involve an association with rewards.

"Now that we know NMDA receptors are required for burst firing in dopamine neurons, we need to explore the mechanisms by which NMDA receptor-mediated bursting is regulated or gated," said Lobb, who is currently pursuing his Ph.D. in Neuroscience at UTSA.

Source: University of Texas at San Antonio

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