

Dopamine signals the value of delayed rewards

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Ball-and-stick model of the dopamine molecule, a neurotransmitter that affects the brain's reward and pleasure centers. Credit: Jynto/Wikipedia

Dopamine is the chemical messenger in the brain most closely associated with pleasure and reward. Recent scientific advances now shed light on



precise roles for dopamine in the reward process.

A new paper published in the current issue of *Biological Psychiatry* implicates dopamine in a person's ability to be motivated by delayed rewards.

People like immediate reinforcement and tend to devalue rewards that are substantially delayed in time. As a result, people will often opt for smaller immediate rewards as opposed to larger delayed rewards when given a choice.

This decision-making process of weighing benefits versus costs for a particular outcome is called "delay discounting". Though we perform these cost-benefit analyses in a seemingly effortless manner, scientists are still learning how the brain performs these complex processes.

In the current study, researchers at the University of North Carolina at Chapel Hill and Stanford University used rodent models to examine the role of this neurotransmitter in dynamically tracking specific elements of value-based decision making.

First, they trained one set of rats to choose between two different options, a small sweet reward that could be eaten right away, or a bigger sweet reward that was delivered only after varying delays.

Senior author Dr. Regina Carelli explained their findings, "We found that dopamine signaled the more preferred option; more dopamine was observed for cues signaling immediate large rewards, but this declined as the delay to the large reward increased." This shift in in dopamine release and associated tendency to choose smaller immediate rewards over larger delayed rewards is consistent with the phenomenon of delay discounting.



Next, using a technique known as optogenetics in a second set of rats, they precisely controlled the activity of <u>dopamine neurons</u> during cues that signaled large or delayed rewards. This experiment revealed that, by 'playing back' the patterns of <u>dopamine release</u> observed in the first set of rats (when they were pondering which choice to make), the researchers could bias them toward making different decisions in the future.

"These exciting new findings suggest that dopamine plays a sophisticated role in helping to guide specific aspects of decision-making behavior," Carelli added.

Dr. John Krystal, Editor of *Biological Psychiatry*, commented, "Delay discounting is an important and poorly understood process. Understanding how it works sheds light on how <u>dopamine</u> signals reward in the brain. It also may help to develop preventive strategies for drug abuse, gambling disorders, and other clinical conditions where delay discounting may play a role."

More information: The article is "Mesolimbic Dopamine Dynamically Tracks, and Is Causally Linked to, Discrete Aspects of Value-Based Decision Making" by Michael P. Saddoris, Jonathan A. Sugam, Garret D. Stuber, Ilana B. Witten, Karl Deisseroth, and Regina M. Carelli (DOI: 10.1016/j.biopsych.2014.10.024). The article appears in *Biological Psychiatry*, Volume 77, Issue 10 (May 15, 2015)

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